THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

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PROFESSOR SCHUSTER'S PRESIDENTIAL ADDRESS.

THE fact that almost the whole of the special subject-matter of Prof. Schuster's able and suggestive address to the mathematical and physical section of the British Association, had reference to electricity, shows how this latter science is gradually absorbing all the other branches of physics.

Prof. Schuster pointed out how much scientific progress owed, in this country, to the scientific amateur; and when we compare the discoveries of our Faradays and our Joules with the output of the laboratories of our richly endowed Universities and Technical schools, we think the point was by no means exaggerated. Prof. Schuster considers that race or education has specially adapted different nations to carry on different kinds of scientific work. For instance, France is unrivalled in the domain of accurate measurement, such as that with which the names of Regnault and Amagat are associated; the best work of the German Universities, appeared to him, to consist in the following up of some theory to its logical conclusions, and submitting it to the test of experiment; while the strongest domain of this country was considered to be that of mathematical physics. Such a classification must, of course, be of a very general nature, but it may help to show the absurdity of attempting to transplant into this country German or other foreign methods or educational institutions. Prof. Schuster also warns us that our school teaching is becoming far too much specialised; a knowledge of scientific theories before the mind is capable of forming an independent judgment having the effect of destroying all originality of ideas. How often, in recent years, have we seen the evil effects of this defect in our methods of scientific education? A prominent teacher promulgates with all the authority of his name, some new (perhaps only tentative) theory, and, immediately, a host of his disciples adopt it and teach it, as one of the accepted facts of science, when a little independent criticism on their part might have shown that the whole elaborate structure rested on a foundation of sand. "At present," says Prof. Schuster, "a knowledge of scientific theories seems to me to kill all knowledge of scientific facts."

Turning to that part of Prof. Schuster's address more especially dealing with electricity, the conviction is forced upon us that electrical research is narrowing the issues and bringing us every day nearer to the true conception of the constitution of matter and the nature of electricity. The experimental verification of Maxwell's mathematical investigations have already led to brilliant successes in the hands of Hertz and others; and the work of Rayleigh, Lodge, and others, on the relation between the motion of matter and the motion of the ether, may yet lead to equally important additions to our knowledge.

Two promising lines of investigation are indicated by

Prof. Schuster, namely, the relation between what we call electricity and the medium, and the relation between electricity and chemical effects. The phenomena of the electric discharge in gases have recently been receiving a great deal of attention from Prof. Schuster and other physicists. The conclusion arrived at is that electricity in a gas is conveyed by the diffusion of particles carrying high charges, probably identical with those carried by the electrolytic ion. The absence of symmetry at the positive and negative poles of the electric discharge in gases has proved one of the most puzzling facts in connection with this subject. One conclusion which has been arrived at in attempting to explain this phenomenon is that a negative electrification of the gas, like that of a solid or a liquid, seems always confined to the surface, while the positive electrification appears to be distributed through a volume of finite thickness. Another important result brought out by the investigations of Schuster and others, is that an electrical discharge through any part of a vessel containing a gas converts the whole gas into a conductor. This effect is supposed to be due to a dissociation of the gas molecules, similar to that which takes place in an electrolyte before conduction takes place. This work is of the greatest interest, and may yet lead to the solution of many cosmical and practical problems.

The Influence of "traces" on Chemical and Physical Properties.

THE marked alteration of the properties of substances by minute traces of impurities has been suspected for a long time, and the recent discoveries in metallurgy are beginning to make this clear. Several times lately we have had occasion to note in these pages instances of the electrical properties of a substance being modified by the presence of traces of some foreign element. It was to be hoped that during the meeting of the British Association some further information might have been forthcoming regarding the *modus operandi* of these phenomena. Prof. Herbert McLeod, in his presidential address to the chemical section of the British Association, at Edinburgh, stated his opinion that the influence of small quantities of impurities may be more common than is generally supposed. Thus an electric spark will not cause a dry mixture of carbonic oxide and oxygen to explode; the presence of moisture seems to be necessary. We might instance another somewhat similar example. Some experiments have recently been made as to the ignition of gunpowder by the electric spark, in which it was found that dry powder could not be readily exploded by a series of sparks from an induction coil, while moist gunpowder speedily took fire. Chemists have been using the word catalysis to express many of these chemical actions which they have been unable to explain. Happily there is reason to believe that the word may soon become obsolete, since an insight is being obtained into many of these hitherto mysterious reactions. It is to be hoped that some will turn their attention to the elucidation of physical differences produced by traces of impurity, and that some difficulties which we run against every now and then in pursuit of the science of electricity may thereby be explained away. The physicist can scarcely get on without the aid of the chemist.

Iron for Dynamos.

THIS week we publish a letter from Messrs. Harold & Jenkins of special interest to dynamo manufacturers, and in addition to the information there given we shall be glad if any of our readers can help us to still more. A firm has just constructed a dynamo which, at 500 revs., gives 100 volts at the terminals, the magnets being made of soft Swedish charcoal iron forged; but as these forgings (which also have to be planed) are very expensive, the manufacturers are desirous of making them of some cheaper material, and they are offered by a large Swedish works magnets of soft Swedish cast Martin iron, and also soft Swedish Bessemer steel smelted down in the furnace with charcoal. The prices of either of these materials is only about half of what the forgings cost, but nothing is known about their permeability. Could anybody give us an opinion about the permeability of these two classes of iron, and also as to their suitability for making the magnets of dynamo machines.

London Overhead Wires.

THE telephone companies are, we understand, very grateful for the action taken by the London Chamber of Commerce in reference to the bye-laws of the County Council for the control of overhead wires, and, we believe, they are well satisfied with the concessions which were granted by the Board of Trade in deference to the evidence offered by the companies themselves, and to the representations coming from the electrical section. Only one clause remained with which they were seriously dissatisfied, and that the one requiring that they should secure permission in their wayleave agreements for the officer of the County Council to inspect a pole and supports on any building at any reasonable time. This was afterwards modified to requiring the Council to give notice beforehand of their intention to inspect, but even this was considered a restriction, and efforts were made to secure the withdrawal of that clause. The President had been appealed to on the subject, but did not see that he could interfere with the right of inspection claimed by the County Council, without making the regulations of no effect. Sir Courtenay Boyle promised to bring the matter again under his notice, although he did not hold out any hope of the objectionable clause being withdrawn. The final decision has been now communicated, which is that the Board cannot see its way to alter or withdraw the clause. The companies contend that it is in excess of the powers granted by the Act, and that in the Bill as laid before Parliament, somewhat similar powers were asked for, but refused. We suppose the companies know how to do it without requiring the advice of the electrical section, but probably they will now adopt the hint thrown out at the last meeting, and frame their agreement so as to convey to proprietors of house property that it is in their own interest to have periodical inspections made by some one other than the agent of the telephone company.

Wind and Water.

OF the engineering papers read before the British Association at its last meeting, two, at least, are suggestive of important modifications in the existing methods of utilising the forces of nature for the purposes of electric lighting and power transmission. We refer to the papers by Profs. Blyth and George Forbes; the former on the utilisation of wind and the latter on the adoption of water power for electrical purposes. Prof. Blyth has advocated the introduction of small windmills for private installations, the energy of a variable windage being suitably stored for lighting lamps at night. Hitherto, electrical engineers have recognised one only of the many methods of storing energy, viz., the chemical secondary battery; but, in his paper, Prof. Forbes suggests the use of water, pumped to a high level, as an efficient and economical mode of storing power in certain localities. There is no doubt that the cheapness of wind power, and the efficiency of water storage, might be combined in favourable localities to produce a very successful lighting station. There is, we believe, a great future for this method of storage, and perhaps a good prospect for the utilisation of wind power. But there is a lesson conveyed by these two papers which we wish to mention; it is the indication which they give of the wide

scope of the knowledge and resource of the electrical engineer of the immediate future. Speaking of the profession collectively, there is no branch of engineering where such a wide scope of knowledge and practical ability is required as in the electrical; and the general introduction of wind engines and hydraulic storage would still further widen it. Water power is, and for long has been, used for the production of electrical power, but this can hardly involve that complete and exhaustive experience of hydraulic engineering which water storage on a large scale necessitates. One of the most extensive branches of civil engineering would thereby become allied to the newer science of electrical engineering. We can even imagine that the affiliation between the electric light and the gas companies, which is so often proposed, will have its counterpart in an affiliation with the water companies. Indeed, in the colonies of Australia and New Zealand, we believe that this latter has already taken place, and that the town water supply is sometimes first employed to drive turbines for electric lighting. And while indicating the enlarging scope of the electrical engineering profession, the prospects of further extension only tend to show how futile is the effort of the single individual to attain a practical knowledge of the whole. As in the living organism, biologically speaking, differentiation must ever accompany an evolution into a complex structure, so in the evolution of our noble profession it becomes more and more incumbent on each member to adopt some one special function. Dean Stanley's definition of a perfect education is specially applicable to that of an engineer, "something of everything and everything of something." An engineer must know the bearings of all branches of his profession, but he cannot *grasp* the whole. Let him grasp tight hold of one branch, and be content with an accurate yet general survey of the others.

Electrodiagnostics.

In our issue for August 5th we briefly noticed some recent experiments by Von Frey on the electrical resistance of the human body, and alluded to the modification of Kohlrausch's method of determining the resistance of electrolytes by means of alternating currents and the telephone, which was employed in the investigation. This method must be still further modified if it is to be applied with success to electro-diagnostics. In such operations a very small electrode is always employed, and hence the metal rheostat may be advantageously replaced by a liquid one consisting of platinum in sulphuric acid, the immersed metal surface being very small. There must be a definite ratio between this surface and the surface of the skin touched by the electrode in order to produce a cessation of the tone in the telephone—that is, when the displacement of phase of the electrical vibrations is to be equalised. The graduation of the rheostat is a somewhat difficult matter, and it is of course only available for a certain range of strength of the current. The surface necessary varies with the region of the body operated upon, and the latter must be thoroughly moistened by immersion in troughs through which the current is passed by cleanly polished zinc plates. The resistance of the body from hand to hand is very small, and, as might be expected, independent of induction currents.

Electricity in Powder Mills.

Owing to the considerable extent to which electric lighting is being adopted in factories for explosives, a series of rules has been drawn up by Her Majesty's Inspectors of explosives, in order to indicate the minimum of precautions which should be observed in all electric light installations in such factories, or in magazines wherein explosive substances are stored. These rules have been largely based upon those issued by the Phœnix Fire Office, with special modifications or additions to suit special cases. Arc lamps, of course, are not to be used, and in illuminating danger buildings, the light is to be arranged in such a way that it is actually outside the building. Whenever there is any liability to the formation of dust, the incandescent lamps are to be immersed in water, or otherwise protected from dust accumulating upon them. This precaution is suggested because some experiments made at Waltham Abbey showed, that if the globe of an incandescent lamp be broken in gunpowder dust, the carbon filament retains sufficient heat and long enough to fire the dust. Lightning conductors have to be *very frequently* examined as to their efficient condition; this is necessary because of the sad experience at the Schlebusch dynamite factory, near Cologne, when during a thunderstorm a heavy discharge of electricity struck the gelatine and washing houses, causing both buildings to explode simultaneously, and yet the lightning conductors had been examined during the previous month, and found to be in perfect order. Perhaps in this case it was the system that was at fault.

Electropathic Belts.

It is evident, from the advertisements now issued by the Medical Battery Company, that its recent action against Mr. Jeffery, in the Bloomsbury County Court, has not resulted quite to the company's advantage. Inducements of all kinds are being held out to influence the inquisitive, the curious, and the unwary, amongst the most recent being the magnanimous offer of the use of the company's experimental room and testing apparatus, free of charge (by appointment) to all physicians and scientists who are unable to obtain such accommodation on their own premises. "This offer is made so that when asked whether Harness's Electropathic Belts are scientifically constructed Electro-Medical appliances, they will be bound to answer Yes, and to admit that the mild currents generated by wearing them are of sufficient strength for all ordinary curative purposes." This is certainly a point with which the medical journals can effectually deal, and we trust that they will lose no time in sounding a warning note to the members of the profession. Judging from one of the letters in our correspondence columns, which Mr. Desmond Fitzgerald has kindly offered us for publication, and which is probably only a sample of others sent to various gentlemen, the President of the Electropathic and Zander Institute is evidently striving his utmost to induce some scientist of standing to associate himself with the company, but whatever opinion a physician—knowing possibly as much about electricity as does the electropathic belt specialist himself—may, in an unguarded moment, give expression to, it is quite unlikely that anybody in the electrical profession will be found to assert that the E.M.F. set up by a disc of zinc and a disc of copper from body moisture will produce any other effect than that to which we testified in our issue of July 22nd. It is, however, only fair to add that the letter dated August 9th, 1892, is pathetic enough to have softened a heart of adamant; so for the welfare of the great British public we trust that other recipients of such letters are made of the same stern stuff as Mr. Fitzgerald.

Ball Lightning.

It is reported by M. A. Veeder, in the New York paper, *Science*, that during a severe thunderstorm on June 27th, the phenomenon of "ball lightning" was seen at the village of Lyons, N.Y. The "ball" was located between a telephone wire and a conductor pipe, about three feet apart, and was "of the nature of an electrical brush preceding the disruptive discharge." The light was of a reddish colour, and when the "ball exploded" there was a report resembling that of a gunshot. No damage was occasioned, and some people who were only five feet away were unable to detect any odour.

THE SCHUCKERT ROTARY FIELD MOTOR.*

ONE of the latest makes of motors designed with a rotary field is Schuckert's. It has been generally described by M. de Bast in this paper. Having had occasion to watch the working of this motor closely, we believe that a detailed description and also an examination into its conditions of working, will be of interest to the reader.

Description of the Motor.

The armature is a simple Gramme ring built up of plates, and similar to that used by Messrs. Dulait, of Charleroi; it is connected to a Gramme collector and also to four metal rings insulated from each other. The connections of these rings with the armature are at the extremities of two diameters at right angles, as is shown in fig. 1.

FIG. 1.

Mr. Schuckert excites the magnets either separately or by a direct current obtainable from two brushes resting on the Gramme collector.

Method of Working.

The rings 1 and 3, by the medium of the brushes, carry a cosinusoidal electromotive force, whilst rings 2 and 4, on the other hand, are connected to a sinuoidal E.M.F.

Let
$$e_1 = \text{E} \cos \alpha t$$
$$e_2 = \text{E} \sin \alpha t$$

be these two E.M.Fs., where $\alpha = \frac{2\pi}{\text{T}}$, T being the time occupied by a complete period.

If we assume that the self-induction of the circuit is practically constant, we shall have in the ring 2 currents differing by 90° in phase.

$$i_1 = \text{I} \cos (\alpha t - \phi)$$
$$i_2 = \text{I} \sin (\alpha t - \phi)$$

in which equations $\phi = \frac{\alpha \text{L}}{r}$, L being the coefficient of self-induction, and r the resistance of the circuit. It is clear that these currents generate a rotary magnetic flux in the ring.

Let us suppose now that we begin to reckon time from the instant that rings 1 and 3 generate a current perpendicular to N, S, thus developing (see fig. 2) two poles, n and s. This implies that we reckon time from the instant when the diameter, a c, makes an angle, ϕ, with A B, the axis of symmetry of the figure.

We have then $t_1 = \frac{\phi}{\alpha}$. $i_1 = \text{I}$. $i_2 = 0$.

And at the end of a further time $\frac{\text{T}}{8}$

$$t = \frac{\text{T}}{8} + \frac{\phi}{\alpha}, \; i_1 = \frac{\text{I}}{\sqrt{2}}, \; i_2 = \frac{\text{I}}{\sqrt{2}}.$$

The resulting poles will then be displaced to n' s'. It will be noticed that the segments a b and c d are not traversed by any current, whilst the segments b c and a d are traversed by a current $i = \sqrt{2}$. I., that is to say, by a current which is greater than the maximum current, I, due to the electromotive force, E, acting alone.

In this case, $$t = \frac{\text{T}}{4} + \frac{\phi}{\alpha}.$$

We have $i_1 = 0$, $i_2 = \text{I}$, and the line n s will be displaced to N S.

In like manner we see that the pole, n, rotates round the ring with the period, T, of the alternating current.

The magnetic flux from n s cutting the pole-pieces excites therein eddy currents which tend to make the pole-pieces rotate, but since they are fixed, the armature begins to rotate in the direction opposite to the arrow.

If the motor is lightly loaded, *e.g.*, about $\frac{1}{6}$th of the normal load, there will be little difference between the angular velocity of the axis of magnetism and that of the armature itself, which takes place in the opposite direction, and so the absolute angular velocity of n s in space will be small. It should be noticed that absolute synchronism can never obtain, even with no load, for a certain current is always required to overcome the mechanical friction of the machine, and hence a small lag must result. The absolute velocity of n s may, however, be so small that if the magnets are excited at the proper moment synchronism may be attained in less than a quarter of a revolution.

In fact, with a separate excitation of the dynamo magnets, as in fig. 3, at the instant when n s coincides with a c, the motor is in reality acting as a continuous current motor, whose armature, as Thomson's rule points out, will tend to rotate in the direction of the outer arrow, *i.e.*, to destroy the synchronism.

On the other hand, if the pole n precedes N, or if the magnets are excited when the point n is reached Thomson's rule shows that the motor will tend to turn with the flux, that is to say it will oppose the motion given to the armature.

This inconvenience can, we think, be avoided by using the Gramme collector of the armature without having recourse to an independent excitation, as then the current being reversed both in the magnets and the armature, as was supposed in the first case, will tend to rotate in the opposite sense to the flux, that is to say, it will destroy the synchronism. It should be noticed, however, that owing to the great virtual resistance of the magnets the change of direction of the current in them takes place slowly. It may happen that

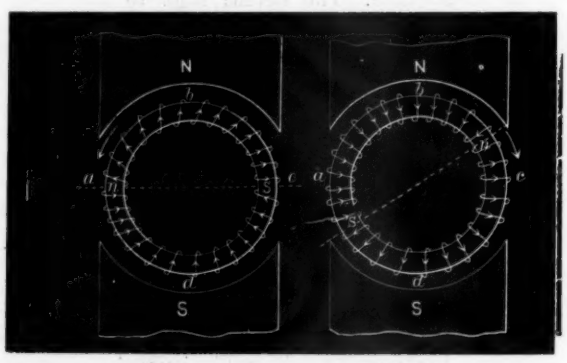


FIG. 2. FIG. 3.

if the absolute velocity of n s is too great, the excitation of the magnets may be constantly lagging by an angle of nearly 90°. We see, then, from Thomson's law, that the motor tends to stop. All these statements have been corroborated by experience.

When synchronism has once been obtained the motor may be given its normal load; a certain limit should not be passed, or the armature may be burnt up. This limit corresponds, as we shall see later, to the maximum output, as the axis, n s, will then occupy the position, a c. We see that if we diminish the load, the speed evidently remaining constant, n s will then make an angle, ϕ, with a c; thus a dynamic equilibrium is obtained, the currents in the wires being in opposition,

* Abstract from an Article by D. Farman in *La Lumiere Electrique*.

Theory.—Let us endeavour to determine :

1. The expression for the maximum power which the motor absorbs as a function of the alternating E.M.Fs. applied to 1, 2, 3 and 4, supposing them to be sinusoidal and the coefficient of self-induction of the circuit being supposed constant.

2. The expression for the maximum turning couple which the armature can produce (it will be shown that this couple is constant during the whole of the revolution and varies only with the load on the motor).

3. The position of $n\ s$, the axis of magnetism for a particular value of E and a fixed opposing couple, not the maximum torque which the motor is capable of overcoming.

Let us denote by

e the difference of potential at an instant t.
E the maximum difference of potential.
r_a the resistance of the armature.
i the current at an instant t.
I the maximum current.
T the period of alternation of the current.
F_0 the flux emanating from one pole.
l the coefficient or self-induction of the circuit.

1. Expression for the maximum power absorbed by the motor.

$$d\,T = -\,d\,W = d\,(i\,F)$$

Now, $i = \rho_1\,(t)$

$F = \rho_2\,(t)$

Hence, $$d\,T = l\,\frac{d\,F}{d\,t}\,.\,d\,t + F\,\frac{d\,i}{d\,t}\,.\,d\,t$$

$$T = \int_0^{\frac{T}{2}} l\,\frac{d\,F}{d\,t}\,.\,d\,t + \int_0^{\frac{T}{2}} F\,\frac{d\,i}{d\,t}\,.\,d\,t.$$

This expression gives the work done by one turn of wire in a revolution.

Let us suppose that synchronism is obtained, a necessary condition if the motor is to turn, for otherwise as we have shown, the turning couple would change direction each half revolution. We shall reckon time, as before, from the instant when this line $a\ c$ of the ring makes an angle $\phi = \frac{a\,l}{r_a}$ with the line A B; in order that $t = \frac{\phi}{a}$ we must have $i_1 = I$ and $i_2 = o$ and $n\ s$ will be perpendicular to the flux N S.

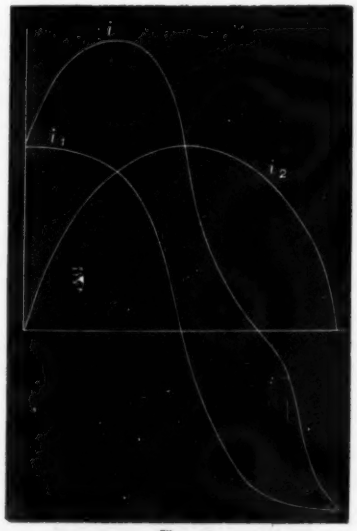


FIG. 4.

It is at once clear that as regards the variations of current in any wire (*e.g.*, the wire at S), due to alternating E.M.Fs., it is immaterial whether we regard the line $n\ s$ as fixed and the ring as rotating, or the ring fixed and $n\ s$ revolving in the opposite direction.

According to this last manner of regarding it, the variation of current in our wire will be represented in fig. 4 by the curve i, and algebraically expressed by

$$i = \frac{E_1}{2\,\sqrt{r_o^2 + a^2\,l^2}}\left[\cos\,(a\,t - \phi) + \sin\,(a\,t - \phi)\right]$$

In order to obtain the expression for the actual current flowing in the armature, we must eliminate from the previous expression the value of the current induced in the wire under consideration by the permanent magnetism which the magnets give rise to.

We thus obtain

$$i = \frac{E_o\left[\cos\,(a\,t - \phi) + \sin\,(a\,t - \phi)\right]}{2\,\sqrt{r_o^2 + a^2\,l^2}} - \frac{d\,F}{d\,t}$$

whence $$\frac{d\,i}{d\,t} = \frac{a\,E_0\,(\cos\,a\,t - \sin\,a\,t)}{2\,\sqrt{r_0^2 + a^2\,l^2}} - \frac{d^2\,F}{d\,t^2}$$

At some moment during the half revolution the flux through the wire will be

$$F = F_0\cos\,(\pi - a\,t) = -\,F_0\cos\,a\,t.$$

whence $$\frac{d\,F}{d\,t} = a\,F_0\sin\,a\,t, \text{ and } \frac{d^2\,F}{d\,t^2} = a^2\,F_0\cos\,a\,t.$$

Substituting for F, $i\,\frac{d\,F}{d\,t}$, $\frac{d\,i}{d\,t}$ their values and noticing that in the expression $\frac{d\,F}{d\,t}\,.\,d\,t$, the sign of $d\,t$ should be negative, since the angles increase in the negative sense, we shall obtain

$$T = -\int_0^{\frac{T}{2}} F_0\,a\sin\,a\,t\,.\,\frac{E_0\left[\cos\,(a\,t - \phi) + \sin\,(a\,t - \phi)\right]}{2\,\sqrt{r_0^2 + a^2\,L^2}} - \frac{d\,F}{d\,t}$$

$$-\int_0^{\frac{T}{2}} F_0\cos\,a\,i\,.\,\frac{a\,E_0\,(\cos\,a\,t - \sin\,a\,t) - \frac{d^2\,F}{d\,t^2}}{2\,\sqrt{r_0^2 + a^2\,L^2}}\,.\,d\,t$$

$$T = \frac{E_0\,a\,F_0}{2\,\sqrt{r_0^2 + a^2\,L^2}}\int_0^{\frac{T}{2}}\Big[\sin a\,t\cos a\,t\,[(\cos\phi + \sin\phi) - 1]$$

$$+ \sin\,a^2\,t\,[\sin\,\phi + \cos\,\phi) - 1] + 1\Big]\,d\,t$$

$$+ \frac{a^2\,F^2}{2\,\sqrt{r_0^2 + a^2\,L^2}}\int_0^{\frac{T}{2}}(\sin^2\,a\,t + \cos^2\,a\,t)\,d\,t$$

$$T = -\,F_0\,\frac{\pi}{2}\cdot\frac{\frac{E_0\,.\,\sin\,\phi + \cos\phi + 1}{2}}{\sqrt{r_0^2 + a^2\,L^2}} + F_0\,\frac{\pi}{2}\cdot\frac{a\,F_0}{\sqrt{r_0^2 + a^2 L^2}} = -\,W$$

In the case of n turns of wire and N revs. per second the expression for F_0 as a function of F, the total flux from one magnet, gives

$$W = F\,N\,n\,\frac{\pi}{2}\cdot\frac{E_0\cdot\frac{\sin\,\phi + \cos\,\phi + 1}{2} - \frac{a\,F}{2}}{\sqrt{r_0^2 + a^2\,L^2}}.$$

But $F\,N\,n$ is the inductive E.M.F. produced in the ring, let us call it e_1 and let us put

$$\frac{\sin\,\phi + \cos\,\phi + 1}{2} = K + \frac{a\,F}{2} - e_2\,.$$

Then

$$W = e_1\,\frac{\pi}{2}\cdot\frac{K\,E_0 - e_2}{\sqrt{r_0^2 + a^2\,L^2}}.$$

Thus we obtain an expression similar to that for the power of a continuous current motor, namely

$$W = e\,i, \text{ where } i = \frac{E - e}{r}.$$

In this case, however, i is represented by

$$I = \frac{K\,E_0 - e_2}{\sqrt{r_0^2 + a^2\,L^2}},$$

in which expression e_2 is a function of the counter E.M.F.

Finally we have $W = e_1\,I\,\frac{\pi}{2}$.

This result is, moreover, in agreement with the working of the motor; the polar line, $n\ s$, being fixed in space the motor behaves each instant as a continuous current machine.

Since the intensity of the current going through it varies every instant, it is the mean intensity which appears in the

expression for the power. The design for such a motor resolves itself to one capable of carrying a current

$$\frac{\pi}{2} \text{I} = \frac{\pi}{2} \cdot \frac{\text{K E}_0 - e_2}{\sqrt{r_0^2 + a^2 \text{L}^2}}$$

II. *Expression of Couple.*

The moving couple is obtained in the same manner as in a continuous current machine by putting work done per second $= 2\pi \text{C N} = \frac{\pi}{2} \text{I } n \text{ N F} = \text{C F } \frac{1}{4} n$ (A), which expression enables us to calculate as a function of E, the maximum couple which the motor can overcome.

III.—*To determine the position which* N S, *the axis of magnetism, will assume for particular values of* E *and the opposing couples, supposed not to be the maximum couple which the motor can overcome.*

The condition for dynamic equilibrium is that the couple exerted by the motor should balance the resisting couple. Let us suppose that the opposing couple $c_1 =$ the nth part of c.

$$c_1 = \frac{c}{n} < \frac{1}{4} n \text{ F}.$$

The motor will then tend to rotate faster and the neutral line, n s, will turn in the same direction. This acceleration will cease when n s has turned through an angle ψ sufficient to restore dynamic equilibrium; in fact, the couple will no longer have the maximum value which it had in equation (A). There will be a certain number of opposing turns which will give rise to an opposing couple and will diminish the value of the flux proceeding from the pole pieces. To arrive at the value of this flux we must calculate the negative work which these opposing turns generate.

As has been shown the wires carry a current $i = \frac{\pi}{4}$ I. a part of the mean total current.

The measure of the change of energy or work produced will be $i\, d$ F or $\frac{\pi}{4}$ I F $(i - \cos \psi)$.

And since there are $\frac{\pi}{2\pi} \psi$ opposing wires we have

$$\frac{\pi}{4} \text{I F} (1 - \cos \psi) \frac{n}{2\pi} \psi \text{ N}.$$

The opposing turns diminish the flux, F, somewhat, but only to such a slight extent that it can be neglected in this general treatise.

We may deduce the value of c_1 from the equation

$$2\pi \text{N } c_1 = \frac{\pi}{2} \text{I } n \text{ F} - \frac{\pi}{4} \text{I F} (1 - \cos \psi) \frac{n}{2\pi} \psi \text{ N}.$$

$$c_1 = \frac{\text{T}}{4} n \text{ F} \left(1 - \frac{1 - \cos \psi}{4} \psi\right)$$

But,

$$c_1 = \frac{c}{n},$$

hence

$$\frac{1}{4} n \text{ F} \left(1 - \frac{1 - \cos \psi}{4}\right) = \text{N } \frac{1}{4} n \cdot \frac{1}{n_1}$$

whence,

$$4 = (1 - \cos \psi) \psi + \frac{4}{n_1}.$$

The value of ψ deduced from this equation will give the angle turned through by n s, when the opposing couple is the ninth part of the maximum couple.

The Motor as a Transformer.

The Schuckert motor can be used as a transformer. We can feed a continuous current circuit with a current, I, from the Gramme collector instead of merely taking up the exciting current. The maximum work which the motor is capable of doing will be in no way affected by this manner of treating the current.

With this method of working the moter, the result is the same as if we had taken the current from the two terminals of a continuous current motor. It only remains therefore to design the conductors and generators with a view to yielding this increase of power, and the motor will work perfectly smoothly. This method of transforming an alternate current into a continuous one is very elegant.

M. Schuckert has adopted Dulait's design in the type of his armature and the arrangement of the magnets. The two top magnets form a north pole, and the two bottom ones a south pole. Fig. 5 shows the flow of lines of force in one half of the armature.

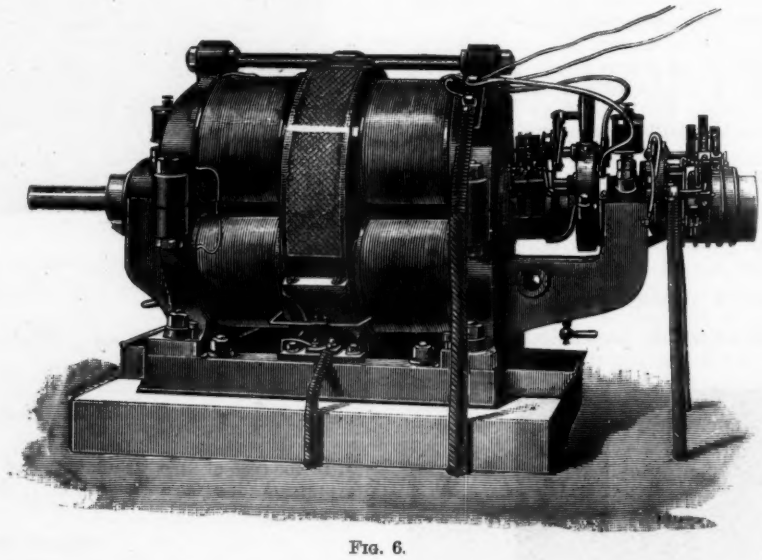


FIG. 6.

FIG. 5.

We consider that the arrangement of the magnets is bad, for since lines of force have a tendency to take the shortest path, the points, 1, 2, 3 and 4 will carry a far greater flow of lines than the other parts of the magnet. This objection will be nullified to some extent if the iron is already approaching saturation, as the flow will then be only slightly greater at 1, 2, 3 and 4 on account of the high magnetic resistance which the iron possesses.

A multipolar motor of the same type will evidently work in the same manner, except as regards speed. If n denote the number of poles, the motor will rotate once whilst the alternate current is making $\frac{n}{2}$ complete periods. These machines are therefore adapted for a definite maximum torque. It should be noticed that the brushes which collect the exciting current can be fixed on any one of the neutral lines determined by the current in the armature. And, further, that the calculation given above contains a slight error. We have assumed that the flow in one turn follows a sine law. This is not quite correct, as the total flux cut in one revolution is equal to that given by the integration of $F_0 \cos \alpha t$, but the calculation of the power will not be affected thereby. The moving couple will no longer be quite constant during a complete revolution if our hypothesis is not satisfied.

Fig. 6 shows a general view of an 8-pole motor.

THE POSITION AND PROSPECTS OF THE ALUMINIUM INDUSTRY.

II.

IN the first of these articles * it was mentioned that the present price of aluminium is nominally 2s. 6d. per lb., but that estimates of what could be done if the electrolytic processes were worked on a large scale point to a price of 1s. per lb. as perfectly obtainable. We have now accordingly to see what openings there are for the metal at these prices, and whether they are sufficient to warrant its manufacture on a sufficient scale to enable it to be produced at anything approaching the lower of the rates mentioned. To do this it will be necessary first of all to go briefly into the properties of the metal itself, and then to deal with its effects when added as an alloy to other metals.

The increased purity of the aluminium lately manufactured has necessitated some change in the estimates which were formerly held of its qualities. The early metal, from which current descriptions have mostly been taken, was considerably contaminated with silicon and iron, which rendered it harder, more brittle, duller, and more difficult to work than it would otherwise have been; the metal now made shows a great improvement in these respects, although it is softer than when less pure.

The most characteristic property of aluminium is its lightness, its S.G. lying between 2·56 and 2·70, depending on how it has been treated An equivalent volume, or bulk, of each of the following metals has, then, the following relative weight to aluminium :—

Aluminium	1·00
Copper	3·50
Brass	3·45
Zinc	2·65
Tin	2·80
Iron	2·80
Silver	4·00

In estimating the relative prices of aluminium and these metals, it is necessary therefore to divide by the above factors. If this is done, then the relative prices of aluminium and copper are now as 5d. is to 7½d., or an enhanced cost of only 50 per cent. for the former metal. A reduction of the price of aluminium to 1s. 6d. per lb. would accordingly place it on an equal footing with copper and brass. It has already been mentioned that on the basis of equal volumes, tin is now dearer than aluminium. The lightness of aluminium must also always be borne in mind when dealing with its adddition to other metals; for instance, the best of the aluminium-copper alloys is the bronze containing 8 to 10 per cent. of aluminium. Now, ordinary brass contains about 32 per cent. of zinc, or a volume which is almost precisely equal to that of the aluminium in the 10 per cent. bronze; the two alloys are, therefore, similar, except that in one case a volume of aluminium replaces a volume of zinc. Again, in adding metals to aluminium with a view to influencing its qualities, it is found that more than 10 per cent. of almost any other metal is useless, and generally even smaller quantities than this produce alloys too brittle to be of any value. It is, therefore, clear that additions of the ordinary metals to aluminium must be under 3 per cent. in volume, from which it may be inferred that the qualities of the metal are considerably altered by small quantities of extraneous elements.

Coming to the mechanical properties of the metal, it is rather softer than copper, but extremely ductile and malleable. It can be cold rolled with a little care into sheets of any fineness, and hardens considerably in the process, becoming, also, much stiffer and elastic; in fact, these sheets retain their shape under stress better than ordinary brass sheets of the same dimensions, though they are not so tough, or capable of being bent to the same extent. They, however, are made exceedingly pliable by being heated to about 400° C., and in this state can be worked in any way, becoming harder as they are bent or hammered. Such sheets can be stamped, spun, or hammered into any shape which copper or silver are capable of assuming, and with but little, if any, more trouble. The tensile strength of the pure metal in the form of hard-rolled sheets is from 12 to 14 tons per square inch, and as such sheets are stiff, it will be seen that they are amply strong enough for a number of purposes for which the lightness and other qualities of the metal render them suitable.

Harder and stronger sheets than those made from the pure metal can be produced by alloying aluminium with small quantities of copper or zinc, though, to some extent, at the expense of malleability. Here is a promising field for experimenting, and it is largely unexplored as yet, partly because sheets of pure metal have been found to answer fairly for most purposes to which they have been so far applied, and partly because sheets containing alloy are more difficult to roll, and need special treatment which can only be learnt by practice and experiment. Splendid results are stated to have been already attained in America by Prof. Langley with an alloy containing titanium, but little definite information is so far obtainable on the subject, while the cost of titanium is so great that it would appear to put the alloy out of court for anything except special work, such as the construction of parts of optical instruments.

What has been said about sheets applies largely to rods and wires, they are produced by cold rolling or drawing with great facility. Rods have a breaking strain of from 8 to 12 tons, depending on their diameter, purity and treatment. For wires the breaking strain is, of course, somewhat higher. In both cases there are the lower limits; by special hard rolling or drawing or by the admixture of a little alloy they can be greatly exceeded, doubled, at any rate. Unfortunately, the elastic limit of the pure rods and wires is not very high, being about one-third of the breaking strain, and their resistance to compression is also rather low; this somewhat limits their usefulness, but much can undoubtedly be done in this direction by judicious treatment of the metal and by the aid of alloys to secure a higher breaking strain, on the one hand, without making the metal too stiff and difficult to work, on the other. There is an important point about rods of pure aluminium, that they can readily be forged cold into almost any shape, while, if requisite, they are easily annealed, after which a few blows will again restore the strength and rigidity of the metal.

As regards tubes, these have, so far, been made chiefly by spinning into approximate form from the sheet and then drawing down to exact dimension; in this way better results have been obtained than by drawing from a cast sleeve, as difficulties have hitherto been found in obtaining sufficiently perfect castings in this form. There does not seem to be any reason now why, with better metal and improved knowledge of working it, solid drawn tubes should not be produced in the same way that they are in copper and brass. Such tubes will largely supplant brass in all kinds of optical and scientific instruments, and wherever lightness is an advantage, though hitherto the demand for tubes has been almost limited to opera and field glasses. Attempts are also being made to use them for bicycles; they will also be useful for portable electric light fittings.

Initially aluminium is an easy metal to cast, and it readily takes the impression of a delicate mould, particularly if mixed with a small amount of alloy. On account of its low specific gravity and a tendency to absorb gases, however, it requires great care to keep it clean when it has to be turned or worked afterwards, for the best results; also it must be used at the right pitch, as frequent remelting de-

* See ELECTRICAL REVIEW for July 15th, 1892.

teriorates it, as it does brass. The pure metal, in the form of castings, has a tensile strength of about 5 tons per square inch. It is rather soft, and pulls very much in the lathe. To improve it in these respects, the addition of a small percentage of alloy is requisite; by proper procedure the metal can be considerably hardened in this way, and its rigidity can be made equal to that of ordinary cast brass. The Phœnix Engineering Company, of Princes Street, S.E., are making a metal of this character, which has already been found useful for a number of purposes.

Now that aluminium has become so much cheaper, a great deal of attention has naturally been devoted to the discovery of a suitable solder, and numerous receipts have been published, while several recent compositions are on the market. Equal weights of aluminium and tin, with 5 per cent. of zinc, make a soft solder, melting at a low heat. Various mixtures of aluminium and zinc, with the addition of cadmium, also make harder solders; these latter are the stronger and easier to work, but their colour is not the same as aluminium. It is one great crux in soldering aluminium to get a solder which will amalgamate with the metal at a lower heat than that at which the metal itself softens, the other difficulty is to find a solder which will flow. It is not difficult to make a strong and satisfactory joint when the two surfaces can be got at, and the solder can be worked into them; but no satisfactory method has yet been found of making the solder flow readily on a surface, or find its way into a joint. A flux of chloride of silver has been proposed for this purpose, without, however, being of much benefit. The means of experiment are, however, now so readily attainable, and the incentive is so great, that this question is sure to receive a vast amount of attention in the next few years. As aluminium is already cheaper than tin, bulk for bulk, and as it will coat an iron surface, an immense field for its use would be opened up, if a ready means of joining two surfaces were forthcoming. For some purposes electric welding will answer very well, but it is not applicable in the majority of instances, where a good solder would be useful.

A great deal has been said *pro* and *con* lately on the action of various re-agents on aluminium, and the following results obtained by MM. Lunge and Schmid, which, in a great measure, set the matter at rest, are therefore interesting.

The authors took strips of sheet aluminium of 99·20 per cent. purity and 1 millimetre thick; these were pierced with a hole, weighed and suspended in the different liquids, where they remained for six days at the ordinary temperature.

Nature of liquids.	Weight in milligrammes lost per 100 square centimetres of surface.
Ordinary red wine	2·84
„ white wine	3·27
Brandy	1·08
Fifty per cent. alcohol	0·61
Tartaric acid 5 per cent. sol.	1·65
„ „ 1 per cent. „	2·58
Acetic „ 5 per cent. „	3·85
„ „ 1 per cent. „	4·38
Citric „ 5 per cent. „	2·15
„ „ 1 per cent. „	1·90
Lactic „ 5 per cent. „	4·77
Butyric „ 3 per cent „	1·31
Coffee	0·50
Tea	0·00
Beer	0·00
Boracic acid 4 per cent. sol.	1·77
Phenelic „ 5 per cent. „	0·23
Salicilic „ ¼ per cent. „	6·35

From this table it will be seen that the greatest loss on a surface about 4 inches square after six days' immersion is 6·35 milligrammes, or less than $\frac{1}{10}$th of a grain. As the action of most of the re-agents is much less than this, it can be said to be practically *nil*. It is, therefore, safe to bring aluminium in contact with foods and beverages. As regards the action of salt water, Mr. A. E. Hunt states that a sheet of aluminium nailed to the wooden bottom of a sailing vessel, and immersed in the sea for four months, showed hardly any reduction of weight; less, if anything, than a similar copper sheet against which it was tested. There is practically no action on aluminium exposed to the atmosphere, while sulphuretted hydrogen has no effect on it.

Strong solutions of caustic soda and potash and hydrochloric acid attack it readily, but these are re-agents with which metals under ordinary circumstances do not come much into contact.

Before closing these remarks the electric conductivity of aluminium must be mentioned; this is about 56 per cent. of that of pure copper for equivalent sections, while for equal weights aluminium is twice as good a conductor. At 10d. to 1s. per lb., aluminium would consequently begin to compete directly with copper for electric mains, wherever a little extra bulk is not detrimental; and although its employment for such purposes is not likely to come about for some years, still any considerable rise in the price of copper would have the immediate effect of greatly stimulating the production of aluminium, which, at any rate, will prevent the cost of copper for mains being permanently raised in any great degree.

Having now briefly reviewed the properties of aluminium, it remains to be seen what uses are likely to be found for it in the early future either as a simple metal or as an alloy with other metals.

A METHOD OF INCREASING THE RANGE OF THE CAPILLARY ELECTROMETER.

The value of the capillary electrometer as an instrument of scientific research is now generally recognised, and its applications are becoming more numerous, both as an extremely delicate test for small electromotive forces, and also, as recently pointed out before the Royal Society (*vide Proc. Roy. Soc.*, Vol. xlviii., p. 89), as a means of studying variations of differences of potential. In view of these facts it is, as everyone will admit, desirable that the range of the instrument be increased. The characteristic curve of Lippmann's electrometer is slightly different from the straight line for electromotive forces from 0·00 to 0·45 volt, and consequently the instrument is most applicable to the measurement of potential differences not exceeding 0·50 volt, although, as is well known, the direct measurements may be carried to about 1·00 volt, since 1·20 volts are required to produce continuous electrolysis in the instrument.

Mr. John Whitmore has been carrying on an important investigation of the capillary electrometer in the Sloane Physical Laboratory at Yale College, U.S.A., with a view to increasing the range of this instrument, and thus adding to its usefulness in scientific research. His attention was directed to the possibility of widening the sphere of usefulness of the electrometer by arranging cells in series; and the results of his numerous experiments may be briefly stated as follows:

By arranging the capillary cells in series their behaviour is not essentially altered when they are subjected to an electromotive force. Hence, in each cell of a series of like cells, the fall of potential is the same. Moreover, when a current of electricity passes through this apparatus, the displacement of the mercury columns varies with the electromotive force, according to the same law as in a single cell, so that the curve showing the relation between the deflections and the electromotive force for any cell of the series is of the well-known form. Accordingly, by means of cells of proper construction, a simple and accurate series-electrometer may be made; such, also, that its range may be increased by increasing the number of component cells.

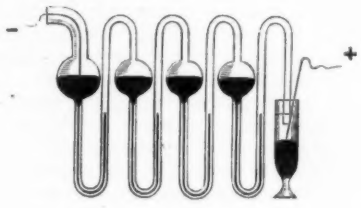
In the American *Journal of Science* for July, Mr. Whitmore describes the preliminary experiments in his investigation, and finally the best form for the wide range electrometer to take, discussing the various advantages and disadvantages of the instrument.

He uses cells in which a small electromotive force produces a large deflection of the mercury columns, and experience has taught him that the most advantageous are those in which the movement of the mercury columns takes place in a vertical tube. Several different forms were tried, but finally that represented in the figure was adopted. This form of figure cell receives simultaneous movements of the mercury in all the cells, and of the same extent, and is compact and well insulated.

The cells are made as follows:—A series of bulbs is blown, spaced at equal intervals along a capillary tube, the diameter of each bulb being two centimetres, that of the tube 0·6 millimeter. Then the tube is so bent, that the whole contain as many U-shaped parts as there are cells. One arm of

each U is provided with a bulb which is situated at a distance of two-thirds the height of the U from the base.

The apparatus is easily filled by connecting it with an aspirator and drawing in sufficient mercury to half fill each bulb. Then by the same means dilute sulphuric acid is added until the capillary tubes and the upper portion of the bulbs are filled and all air bubbles excluded. Previous to the filling of the instrument, a solution of pure sulphuric acid in distilled water, consisting of four volumes of water



to one of acid is prepared, and allowed to stand until all the bubbles of gas formed by the mixture disappear. This is afterwards diluted, if necessary, with distilled water to the proper proportion.

The operation of filling the electrometer is greatly facilitated by having the tube which enters the upper part of the last bulb of the series of much greater calibre than that of the others, and the extremity may be curved so that the terminal portion is at right angles to the vertical parts.

Platinum wires are used as electrodes in the usual manner. As Lippmann has noted, the electrometer acquires a charge during the operation of filling, and therefore the instrument should be short-circuited for an hour or more before using, so that this charge may be wholly dissipated, and the mercury columns may stand at their true zero positions.

The instrument, having been filled in the manner described, is firmly mounted, and placed on a pier before a cathetometer, by which all observations may be made in hundredths of a millimeter. Then the curve showing the relation between the deflections is constructed. From this curve the absolute value of the electromotive force corresponding to any deflection can be determined by taking the deflection produced by a standard Clark cell as a means of comparison.

It is noteworthy, that not only is this electrometer valuable as a means of quickly comparing low electromotive forces, but that a high degree of accuracy is obtainable in this comparison. Thus a number of cells, which had been standing in the laboratory, were measured by Mr. Whitmore, with the capillary electrometer, and immediately afterwards the absolute values were found by the compensation method with the following results, showing a striking agreement.

Cell.	Thomson's balance method. volts.	Capillary electrometer. volts.
Silver chloride	1·020	1·025
Dry cell	1·446	1·440
Leclanché	1·453	1·458
Daniell	1·076	1·081

Thus it is seen that, even with a cathetometer reading only to hundredths of a millimeter, and having a telescope of low magnifying power, values correct to one-half of 1 per cent. may be obtained. Mr. Whitmore believes it possible to determine the electromotive force of a cell correctly to 0·001 volt with this modified electromoter.

The accuracy with which measurements may be made may be increased somewhat by increasing the number of cells.

ELECTRICITY IN BITUMINOUS COAL MINES.

Mr. Elmer A. Sperry has paid as much attention to this class of work as any American, and hence the paper he recently read before the Institute of Engineers at Chicago has an especial value. The technical part is prefaced by an interesting account of the coal fields of the United States, and also by a short pithy description of the method of working the seams. Englishmen are in the habit of regarding American coal as almost exclusively anthracitic, but, according to Mr. Sperry, the bituminous fields are of enormous extent, and last year 150,000,000 tons of this class of coal were raised, chiefly in the Western states. And on one of the affluents of the Mississippi river in 1888 there was shipped nearly as much coal as was mined in the whole of Europe during the same period. In this valley there are 152,000 square miles of coal. To enable his hearers to grasp what this quantity really means, Mr. Sperry stated that the coalfields of Great Britain were about 9,000 square miles in extent, and that the Mississippi fields cover an area some 30,000 square miles larger than the superficial surface of the United Kingdom.

With such an unequalled field of operations in the most enterprising of modern countries, there is no wonder that electrical working should have met with much encouragement and no little success. Mr. Sperry has devised a variety of mining machines to meet different requirements, and finds them in all cases to be successful, both from the commercial and the engineering point of view. He has built "coal-picks" with solenoids, and also with motors actuating cams. He much prefers the latter type of machine, as it gives not only a heavier blow, but is more efficient, and does not heat so much. It is now well recognised that solenoidal action, as applied to-day, is not suitable for the continuous work which is necessary with rock-drills and coal-picks. We have frequently pointed this out to our readers, and note our opinions are again confirmed. The Sperry coal-pick and rock-drill have already been described, and we need make no further reference to them.

A light coal cutter for use in long-wall working, which seems to be very promising, is alluded to. The description is, however, too meagre for us to thoroughly grasp the design. It somewhat resembles the side-wheel coal cutter used in England, but the wheel is driven by a steel chain having blades or cutters fixed at intervals, so that the wheel simply forms a centre round which the cutting chain rotates. The overall dimensions are 5 feet in length, 20 inches in width, and 18 inches in height. These machines usually hole in the "dirt" under the coal, and absorb about 220 volts, and from 22 to 35 ampères. If they are as good as the description seems to warrant, there is a large future before them.

Another branch in which Mr. Sperry has introduced many improvements is electric haulage. He has recently designed several electric locomotives weighing from 8 to 10 tons. These have two four-wheeled trucks, and the eight wheels are all coupled by an ingenious arrangement. The motor forms part of the frame of the loco and is coupled to both trollies by suitable gearing. The driving wheels on the rolling axles are mounted by a kind of ball and socket device, so that the trollies can run round very sharp curves, as small as 9 feet radius, without materially altering the depth of the gearing. This is a very simple contrivance and seems to work well. The largest motor up to date built for this class of work is of 125 H.P. capacity. The highest pressure yet used is 250 volts, so that the current required must be in the neighbourhood of 400 ampères. Mr. Sperry finds no difficulty in taking this large current from the overhead line and returning it through the metals. The train speed obtained is sometimes as great as 30 miles per hour. Undoubtedly the success of these electric locomotives is largely due to the flexible wheel base.

The dynamos for mining work are about 7 tons in weight and compound wound. Since the terminal voltage is only from 250 to 300 volts, and the current output of each machine is probably 500 ampères, the copper mains must be very large and form a heavy item in the total cost of the plant.

Another point worthy of serious attention by English engineers is the use of a spring cushion between the motor shaft and the pinions. Mr. Sperry does not describe in detail the way in which he carries out the idea, but there can be no doubt that the life of the armature is greatly extended by this simple device. It has been tried in various ways for tramcar work, but somehow has always been ultimately discarded possibly owing to defective mechanical design.

Other inventors have also found the mining field both profitable and interesting, and we may expect rapid progress in the applications of electricity. The unrivalled water power of America, and the various labour difficulties all tend to encourage the use of machinery. Most of the large companies have already recognised the true bearings of the question and have established mining departments.

WATER POWER.

BY E. TREMLETT CARTER.

I.

1. *Introduction.*—The present series of papers on water power is written with a single purpose—to enable electrical engineers to grapple in a practical fashion with the many problems in the electrical utilisation of water power. The practice of every branch of engineering is assisted by some knowledge of the theory of that branch, and this is especially true of water power engineering. A steam engineer may succeed without understanding the intricate principles of thermo-dynamics; but no engineer can go to a mill site and make the necessary tests, and design and erect the necessary machinery, unless the principles of hydromechanics and the theory of water motors are well understood. Such theory as he would require will, therefore, be discussed in this series of papers; and since it is a simple theory, the writer hopes to make it interesting. Besides theory, the series will contain some description of the various types of water motors, a discussion of the rules for designing and erecting these, and some account of the actual practice and experience of stations where electric power is developed from water power.

2. *The Sources of Energy.*—If a weight lies on the floor work must be done to raise it to any height above the floor, and energy will be conferred on the raised mass of matter. This energy is equal to the product of the force overcome in lifting it, into the vertical distance through which it is raised, and is independent of the time taken and of the path through which the weight is raised. The energy thus communicated to the mass, by virtue of its change of place, will enable it to do useful or other work in descending to the level from which it is raised, the total work it will do being equal to the energy it received. Consider now a mass of water in a river or the sea—say, at Trinity low water mark—this may be raised to a considerable height above this level by either of two natural forces. The heat of the sun may evaporate the mass of water, and by making it specifically lighter than the air, may raise it to the level of the clouds; or the gravitational attraction of the moon may act upon it, raising it to the level of high tide. In the former case the energy has been conferred by solar heat; in the latter, partly by the earth's rotational energy, through the medium of the moon, and partly by the translational energy of the moon herself. Of the latter source of energy—the tides—we shall not at present take any notice, confining our attention to the energy of fresh water.

It will be seen that, as in all prime movers, the water is not itself the source of energy but is merely the working substance. The utility of water above every other material, as a working substance for "gravity engines," lies in the fact that its operation is cyclical, for when it has descended to the valley it is forthwith evaporated again to the mountain top; its fluidity is also an advantage.

Fresh water weighs about 62·4 lbs. per cubic foot, so that the potential energy of any volume of water at a height H feet above a given level, measured with respect to that level, is

$$E = 62{\cdot}4\ Q\ H \text{ foot lbs.}$$

where Q is the volume in cubic feet. The height, H, is called *total head* which the water possesses at this place, if the water is at rest; and the *head due to gravity*, if it is in motion. In addition to potential energy, the water may possess energy of motion—kinetic energy. This it will have acquired in virtue of a fall from a still higher point, at a height, h, above its present position; this height being called the *head due to velocity*. The sum of H and h gives the total head at the place, with respect to the level from which the height, H, is measured, and the product of the weight of water into the total head gives the sum of the potential and kinetic energies,

$$\text{Total energy} = 62{\cdot}4\ Q\ H + \tfrac{1}{2}\ M\ v^2,$$

and,

$$v^2 = 2\ g\ h,$$

whence,

$$\text{Total energy} = 62{\cdot}4\ Q\ (H + h).$$

When these quantities are measured at a mill-site the quantity, H, is called the *fall*, their sum only being called the head. Thus the fall at a mill site is the difference in level between the upper and lower ends of the site, due to the declivity of the stream on the site. A *natural fall* is that in which the declivity is unaltered by engineering; an *artificial fall*, that in which the difference in level has been increased by constructive works. Thus the chief essentials of a mill site are:—

(*a.*) An available head, consisting partly of a local fall in the ground level, and partly of a certain velocity of stream; or a condition of things rendering the development of this possible.

(*b.*) A sufficient stream or regular flow of water, according to the demand for power. Many streams, which in the winter months yield abundant power, are almost dry in summer. This should be taken into account.

3. *Choice of a Mill Site.*—After making liberal allowances for the unavoidable losses of power, there should remain over a sufficient power for useful purposes; and in choosing a mill site this point must be kept well in view. There are mills in this country which are worked by water for only seven or eight months in the year, expensive steam engines being kept idle during that time in order to supply power when the water fails. In many cases this could be avoided by the choice of a neighbouring site, or by a different construction of the works on the same site. It will, of course, be evident that where the power is to be used only for electric lighting a considerable drop in the quantity of water in summer is of no serious consequence, for there will also be a serious drop in the demand for light. The total power developed on any site is—

$$\text{H.P.} = \frac{62{\cdot}4\ Q\ (H + h)}{550},$$

where Q is the flow of water in cubic feet per second. The deductions which must be made for losses will be dealt with subsequently; they vary from 20 to 60 per cent.

When surveying a mill site to determine its suitability, the following observations must be made:—(*a*) The natural fall; (*b*) the velocity of the stream; (*c*) the practicable amount of artificial fall; (*d*) the quantity of the flow; (*e*) the variability of the flow; (*f*) the nature of the stream bed and surrounding soils; and (*g*) the amount of space available for a reservoir. These are severally estimated in the following manner:—

4. *The Natural Fall.*—A simple operation in levelling will enable one to measure this. A theodolite and one or two 12-feet rods are required, the latter consisting of light poles painted alternately with two colours, each length of colour being one foot, and usually numbered. The manner of taking the survey is shown in fig. 1. One of the rods is

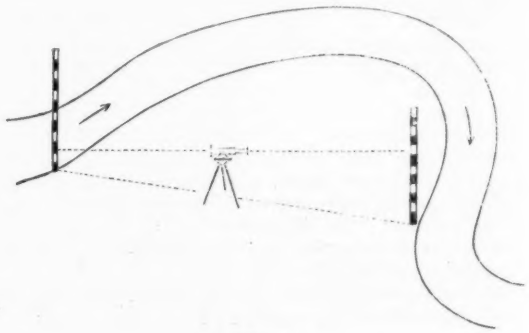


FIG 1.

held vertically at the upper end of the site, the bottom of the rod being level with the stream. The theodolite is now placed somewhere on the site at a convenient distance away, and after being set accurately level by means of the spirit levels the reading on the rod is taken. The rod is now removed to, or another is held at, some point on the other side of the theodolite further down the mill site; and the telescope is turned round horizontally till the reading on the lower rod can be taken. The difference between the readings gives, of course, the fall from the first to the second rod. The theodolite is now taken to some point further down the site on the other side of the second rod, and a new reading

taken on this rod. Thus the operation is continued, till the level of the stream at the lower end of the site is reached. The sum of the differences of the sets or pairs of readings gives the total fall on the site.

5. *Velocity of Stream.* — All parts of the section of a stream do not move with the same velocity, on account of the friction of the bed and the action of curves. It is usual to ascertain two only of the velocities, viz., that at the middle of the surface of the stream and that close to the bed. The mean velocity of the stream differs by a negligible amount from the average of these two speeds. Or Prony's formula, $v_m = v\left(\frac{7{\cdot}71 + v}{10{\cdot}28 + v}\right)$ may be applied; where v is the velocity at mid-stream. Current meters—instrument resembling a ship's log—are sometimes used for the purpose of taking the velocity of a part of the stream. The instrument is fixed at the end of a long pole, the other end of which is manipulated from the bank, and is dipped into the middle and sides of the stream. If the observation is made on a bend in the stream, the velocity at both banks must be taken, as there is a serious difference; the mean of these is taken as the velocity over the bed. These tests must of course be made at the upper end of the site. Another way to find the velocity of the stream which is sometimes adopted, is to place a cork or other float at some part of the stream, and to time its motion from one place to another at a known distance away. This method is very crude, and does not give the velocity at the one place where it is to be determined, namely at the top of the site.

6. *Artificial Fall.*—In order to bring the whole of the natural fall to the spot where the engine is to be placed, as well as to increase the fall, most mill-sites will require some constructive work. The usual practice is to place a dam or *weir* wholly or partially across the stream, thus ponding the water back and raising the level of the top water at the engine. There are several advantages to be derived from this. (*a*) With increased fall more efficient engines may be used. (*b*) By ponding the water back the total head is increased, for the losses due to friction on the stream-bed are reduced. (*c*) The ponded water is a store which may be partially drawn upon when there is a temporary call for increased power. (*d*) The reduced velocity of the stream which ponding back produces, is a source of economy, in that there is less destruction of the water ways.

It will in general be the object of the engineer to get as high a top water level as possible, but he will have to consider the following limitations. If the top water is raised too much by means of a weir it is possible that the tail race of the next mill further up the river will be flooded, which would result in litigation; or the level of the stream might rise sufficiently to enable it to overflow its banks. In deciding upon the height of the top water it will be necessary to know the levels of the banks for some distance up the stream, which will be determined by means of a theodolite.

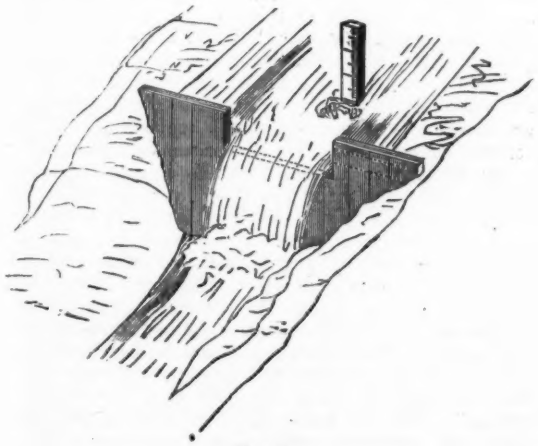


FIG. 2.

7. *Quantity of Flow.*—The method adopted in determining this will depend on the size of the stream. At small streams it is best to employ a temporary weir or notch-board, placed across the stream in such a way that the whole of the water must flow through a rectangular or V-notch of known dimensions. Fig. 2 shows the usual form of notch-board, and the manner of using it. A vertical scale, divided into feet and tenths, is placed in the backwater where the current is practically zero, the zero mark on the scale being at the bottom and on a level with the sill of the notch. The reading on this scale at the surface of the water gives the fall to the sill. Calling this reading h, and the breadth of the notch at the surface of the calm stream b, the flow in cubic feet per second is,

$$Q = \frac{2}{3} c \,.\, b \,.\, h \,.\, \sqrt{2 \,.\, g \,.\, h}, \quad \text{(for a rectangular notch).}$$

$$Q = \frac{8}{15} c \,.\, \frac{b \,.\, h}{2} \sqrt{2 \,.\, g \,.\, h}, \quad \text{(for a V-notch),}$$

where c is a constant, called the *coefficient of contraction* of the stream. The values of c for notch boards are :—

(a) for a V-notch—

when $b = 2\,h$, $c = 0{\cdot}595$,

when $b = 4\,h$, $c = 0{\cdot}640$;

(b) for a rectangular notch—

$$c = 0{\cdot}57 + \frac{b}{10\,B},$$

where B is the width of the stream. Usually the notch is about three-quarters of the width of the stream, though it is occasionally only one-quarter. The sill and sides of the notch should be bevelled to a sharp angle, presenting a flat side to the top water and an inclined or bevelled side to the outflow, and should be faced with sheet iron to reduce the friction.

The variability of the flow with the seasons can usually be fairly estimated by enquiry of people in the neighbourhood, a much quicker method than a series of observations. A good engineer can, of course, often judge the probable variation from the nature of the watershed.

8. *Soils.*—An examination of the bed and banks to discover the nature of the soils is useful as a guide in deciding upon the constructive work which must be carried out. As will presently be seen, the form and size of most of the works will be partly determined by the character of the soil. Besides this, a knowledge of the soil is necessary in order to fix upon the cost of the plant, as well as to enable one to judge the loss of head which will occur in the waterways. These particulars will be dealt with fully, and the question of reservoir space will also be discussed, in the sequel.

9. *Weirs.*—Some description will now be given of the several details of the mill, which it will be necessary to construct before actually erecting the engine. The uses of a weir have already been enumerated; we will now consider its construction. Weirs are either *continuous* or *discontinuous*, according as they allow the water to flow over the whole or only a portion of their width; and *drowned* or *not drowned* according as the height of the crest is or is not below the

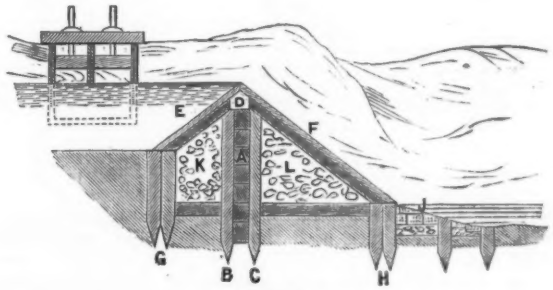


FIG. 3.

natural level of the stream. The difference in level produced by the weir is called the *swell*; and a discontinuous or not-drowned weir, or both, will be used for high swells, and a continuous or drowned weir, or both, for moderate or small swells. It is not often the case that the bed of the stream is sufficiently rocky to enable the weir to be placed securely across the stream without pile driving. Fig. 3 shows the manner of pile driving and erecting a wooden weir, and fig. 4 shows the same for a weir of masonry. In fig. 3 a barrier

of horizontal baulks of timber, placed one on the other at A, is held in place by means of two rows of vertical piles, B and C. At the top of this structure the saddle beam, D, is placed, forming a support for the slanting planks which form the brest and apron of the weir at E and F. The other ends of these planks rest on piles driven in at G and H, and the apron is continued a short distance by a course of sloping brick-

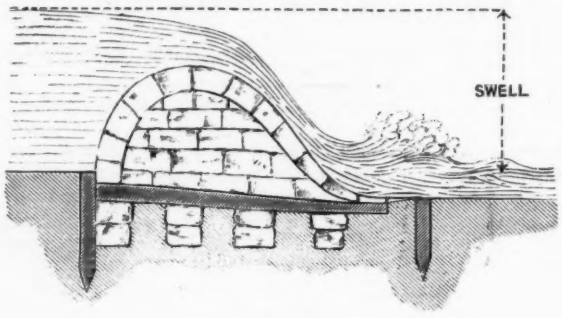


FIG 4.

work at J. The spaces, K and L, are filled in with stones, clay, or cement. The position of the sluice gate, leading to the mill race or waterway, is shown at M. The height of the crest or saddle above the bed of the stream will be determined by the maximum quantity of water which must flow over the weir per second, and the top level which it is desired to have when this flow occurs. The height of the surface of the water, where it is level, above the crest of the weir, is given by the formula

$$h = \sqrt[3]{\frac{Q^2}{7\,b^2}}\,.$$

The difference between this height and the total top level gives the height of the crest.

Besides the overfall weirs described in the foregoing paragraph, there are various forms of sluice weirs, the object of which is to permit the escape of water only during freshets, or when the mill is not at work. These are generally used in combination with an overfall weir, the former carrying away unusually heavy floods, and the latter regulating the height of the working top water. A common form of automatic sluice weir is shown in fig. 5 ; it is usually placed in a

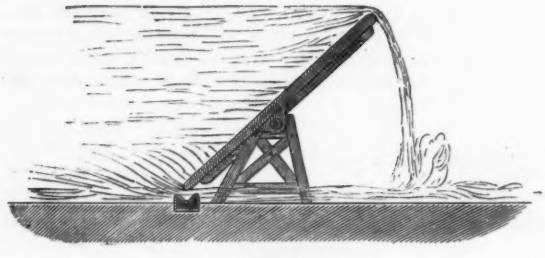


FIG. 5.

separate channel, called the *bye-wash*, connecting the upper mill race, or head race, with the stream below the overfall weir.

10. *The Pond.*—Whenever it is desired to use the water at a greater rate than it is supplied, as, for instance, when the flow during 24 hours is utilised in a fraction of that time, water must be stored in a mill pond. It may happen that the amplitude of the weir causes an accumulation of top water in the natural channel of the stream, sufficient for this purpose, but it will frequently be necessary to excavate a separate pond, or to widen the natural channel. The size of the pond depends on the amount of water to be stored between two successive periods of working the engine, and on the fluctuation of head which can be permitted. Thus, if the stream constantly supplies Q cubic feet per second, and the mill is required to work for t consecutive hours out of the 24, the amount to be stored during the hours of idleness will be

$$3{,}600\ Q\ (24 - t) \text{ cubic feet.}$$

This will raise the level of the water in the pond.

Calling h the rise in level, and A the area of the pond in square feet, the product $A \,.\, h$ gives the amount stored ; whence

$$3{,}600\ Q\ (24 - t) = A \,.\, h,$$

and

$$A = \frac{3{,}600\ Q\ (24 - t)}{h} \text{ square feet.}$$

A very common fluctuation of level in the pond is from 5 to 10 per cent. of the available head.

Where water is scarce and the soil is light and sandy, it may pay to cement the floor and sides of the pond, or to ram them with stiff clay to a thickness of about a foot ; but, as a rule, the natural soil forms a sufficiently effective bed for the ponded water. The sides of the pond must be inclined at a very small gradient, the amount of which will depend on the lightness of the soil. For light soils the angle of the sides with the horizontal must not exceed 20 to 25 degrees, but stiff soils may be steeper.

(*To be continued.*)

CHICAGO EXHIBITION.

A FEW weeks ago we referred to the discussion which had taken place at the meeting of the Electrical Section of the London Chamber of Commerce as to the advisability of making some combined effort to make a representative electrical exhibit at the forthcoming exhibition in Chicago. The secretary of that body issued a circular to the whole of the members of the electrical section — and we believe it is fairly representative of the trade—which certainly seems to have been prepared with the object of carrying conviction to the minds of its recipients, but we regret to hear that the issue of the circular in question has not met with a single favourable response. Exhibitions have, no doubt, been greatly overdone of late, but we think the determination of the trade not to show itself at the World's Fair is rather to be regretted. Everyone knows that when the late Crystal Palace Exhibition was projected many first-rate firms were firmly opposed to having any exhibition at all, and endeavours were at that time made to get the directors of the Crystal Palace to postpone the exhibition altogether. There was, we say, a decided disinclination to exhibit on the part of very many firms in the trade. But they had to exhibit in the long run, and why ? Simply because they felt themselves bound to follow in the wake of those who had already promised to do so. The force of competition would not allow them to remain behind. And if this skeleton of competition haunts us to such an extent as to constitute itself an unanswerable argument, and compels such action to be taken in regard to an exhibition at our own doors, does it not apply with tenfold force to international competition. The American Commissioner has already declared in London that the object of this great exhibition is to wrest from us a considerable portion of the trade which we now carry on with South America, Canada, and our other colonies in the new world, who, they contend, by geographical and other conditions, ought to make them more their neighbours than they are ours. Our Yankee friends bid the world come and see at Chicago the result of the inventiveness and perseverance of their citizens. These attributes cannot be denied them, and there is very little doubt that they will do their best to prove the truth of their own idea that they "can lick creation." But no doubt the trade find it difficult to realise how we can be said to have lost that which we never possessed, but there is such a thing as prospective loss as well as prospective gain, and if the exhibition does for the Americans what they hope it will do, then we may look upon our not exhibiting at Chicago as a prospective loss. With our exports decreasing seriously month by month, it

might be supposed that the necessity for not only retaining our present markets, but the necessity for finding new openings would prove an irresistible argument why we should endeavour to prove that our creations are made of sterner stuff than to be hopelessly snuffed out by a McKinley tariff. We are afraid, however, that self interest presents itself to the trade as a more practical issue than the common commercial good, which may account for the universal disinclination to exhibit, combined with a general sulkiness at treatment which may appear to be very much akin to the fable of the fox and the stork—inviting us to a feast and yet making the conditions such as to make our acceptance impossible. To stay away, however, is to pay the greatest possible compliment to the superior commercial acumen of the projectors of the McKinley tariff, inasmuch as it proves that the desired effect has been produced, that of excluding the Britisher. But with a Presidential election in the United States, admittedly fought on the tariff question, who would venture to insure the life of the McKinley tariff. Its demise at no distant date seems more than probable. But supposing that it proved to have a much longer lease of life than we think it ever likely to enjoy, traders seem to imagine that it must act as an effectual barrier to trade with the United States. We do not agree with this. If we can at such an exhibition prove that we have a superior class of goods, or that we can do what the American has not yet done, then the history of trade confirms us in the belief that we will be called in to supply goods, then the people will have them irrespective of the price, and that which is wanted will command an entry for itself into foreign ports in spite of all the hostile tariffs that statesmen can possibly devise.

THE BRITISH ASSOCIATION.

POWER TRANSMISSION BY ALTERNATING CURRENT.

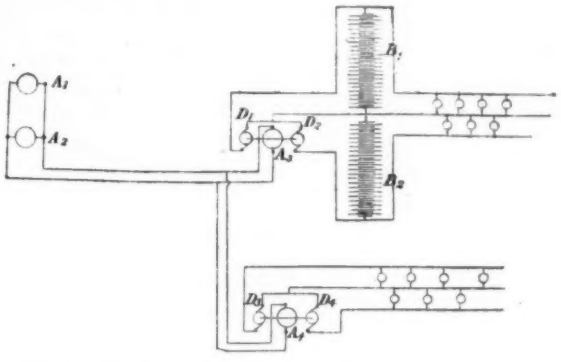
By GISBERT KAPP.

(Read before Section G, August 8th.)

SOME two years ago the municipal authorities of Cassel, in Germany, determined to become purveyors of electric light and to place the generating station on the site of the waterworks pumping station, which is situated on the river Fulda about four miles from the town. The object in choosing this site was partly to bring both undertakings under the same management, and so reduce administrative expenses, but chiefly to utilise an existing turbine plant which had been erected for driving pumps to augment the natural supply of water by gravitation, which was found in the hot summer months to be scarcely sufficient for the requirements of Cassel. The gravitation supply being abundant during the rest of the year, the turbine plant and an auxiliary steam engine erected as a stand-by to the turbines represented so much idle capital during all the time that motive power was not required for pumping. It was thus obviously good policy to put the central electric station on the site occupied by the waterworks, using for motive power the turbine plant and stand-by engine already existing, and this the more so as the two services, namely, water and light supply do scarcely, if at all, overlap. In summer when the greater part of the power obtainable from the turbines is required for pumping, the demand for light is a minimum, whilst in winter when the whole of the turbine power is required for lighting the pumps need not be worked, the water supply by gravitation being, as already stated, amply sufficient.

Having laid down this policy, the problem to be faced was how it could be carried into effect; and this was not such an easy matter as might appear at the first glance. It would, of course, have been possibly to lay down an ordinary alternating current station, but this would not have been a good solution of the problem. In the first place, the total number of lamps that could have been installed would not have exceeded 2,500 of 60-C.P., corresponding with the maximum of 200 H.P. available at the pumping station; and in the second place, the low load factor of alternating current supply would have operated against the very object the Municipality had in view, namely, to make the best use possible of their existing power plant. In order to carry out this object, it was obviously necessary to adopt some system of storage so that the turbines could work at full power continuously. With such a system the number of lamps installed could, at the same time, be materially increased. Thus, an ordinary direct current station with batteries might have given these advantages, but for one, and that a very serious, obstacle, namely, the great distance between the generating station and the town. It was evidently necessary to work at high pressure and to use some system of transportation at a sub-station in the town, but high pressure direct current dynamos present difficulties which one would rather avoid than face, whilst the insulation of some 1,000 storage cells in series when charging, and their grouping in ten parallels of 100 and regulation whilst discharging present very serious difficulties and introduce complications. It will thus be seen that neither the ordinary alternating current system, nor the ordinary direct current system with batteries, nor the so-called Chelsea system, presented a satisfactory solution of the problem involved in the lighting of Cassel. It was nevertheless solved in a very successful manner by a German engineer, Herr Oskar von Miller, who had been called in by the Municipality to carry out the work. The plan adopted by von Miller was briefly this. He determined to transmit power by single phase alternating current from the generating station to a sub-station or rather to two sub-stations in Cassel, and to use this power for the supply of direct current on the three-wire system. At one of the sub-stations he established a battery which is charged during the hours of light load, and assists the dynamos during the hours of heavy load, so that the maximum power available shall suffice for 3,500 60-C.P. lamps wired.

The general arrangement of this installation is shown in the accompanying diagram: A_1 A_2, are two 60 K.W. alternators at the generating station. These can be used singly or in parallel, and the current is



transmitted through an underground concentric cable over a distance of about four miles to the sub-stations shown on the right of the diagram. The sectional area of each conductor is ·093 square inch, and the total resistance about 3·5 ohms. The alternators are designed for a terminal pressure of from 2,000 to 2,200 volts, so that the loss in transmission, when both are working full power, is under 10 per cent.

Each sub-station contains an alternating continuous current transformer, consisting of a 60 K.W. alternator, A_3, A_4, coupled with two continuous current dynamos, one on either side, D_1, D_2, and D_3, D_4 respectively. The latter machines are connected with each other and with the mains in the usual way adopted in three-wire distribution. At one of the sub-stations there is a battery, B_1 B_2, also arranged on the three-wire system. The mains throughout the district are coupled so that the battery sub-station can supply current to the other sub-station through the town mains. To start any one of the two transformers it is only necessary to switch on the two dynamos which begin to work as motors, and after observing by a synchroniser that the speed of the alternator has reached the required amount to close the high pressure alternating current switch when the alternator works as a motor supplying power to the two dynamos which are directly coupled to it. It will thus be seen that not only are the two alternators at the generating station worked in parallel, but also the two sub-station alternators erected in different parts of the town are worked in parallel. The dynamos are Brown's design and the alternators are my design, both made by the Oerlikon Engineering Works, but I must distinctly state that I can claim no credit whatever for the Cassel installation; and that the whole credit for this (probably the earliest) example of power transmission by alternating currents is due to von Miller who, at a time when most electricians were still in doubt as to the possibility of parallel running, boldly laid down a plant, the success of which was not only dependent on parallel running, but also on the economical and safe transmission of power by single phase alternating current, using for this purpose the ordinary type of alternator as made for lighting. The plant was started on May 15th last year and has been working since then without a hitch.

By the courtesy of Herr von Miller I am able to give the following readings of the working of the battery sub-station taken at my request about a month ago. Although at that time of the year the load is necessarily light the total efficiency of the transformer, even if we neglect the correction due to lag, is satisfactory.

ALTERNATING TO CONTINUOUS CURRENT TRANSFORMER.

Alternating current motor.				Continuous current generators.			
				Machine I.		Machine II.	
Speed.	Exciting current.	Terminal volts.	Armature current.	Volts.	Ampéres	Volts.	Ampéres
500	10	1,820	23	130	120	134	130
460	10	1,800	20	112	120	113	120
475	10	1,840	20	111	125	117	115
475	10	1,800	22	120	128	116	118
470	10	1,800	22	112	127	128	110
465	10	1,820	22	122	115	120	122

DISCUSSION.

Prof. FORBES said this was a most interesting method of lighting, and there were likely to be many applications of the same sort, and, he believed, these were the first results giving us the efficiency of this combination. Electricians owe much to Mr. Kapp's ingenuity of resource in the way in which he brings such matters before them. He then asked Mr. Kapp if he had made any experiments to put the alternators out of step.

Mr. PREECE said there was another point—it was this. Mr. Kapp had given for the first time, an answer to what has been often said, to objections which have been raised with regard to alternating current systems, in connection with the use of motors and with the charging of secondary batteries. There was greater safety with high pressure alternating currents, because greater precautions were taken, and also stringent regulations were laid down, thus leading to greater safety.

General WEBBER threw doubts on the novelty of the system, and said although he could not give an instance at the moment, he could probably recall several within 24 hours.

Mr. KAPP, in reply, said he would like to have some examples from General Webber, but at the same time pointed out that the system described had been running two years, and in answer to Prof. Forbes said he would not object at all to break down the synchronism of the alternators; they simply made a fearful howl, but nothing more.

EARTH CURRENTS.

By W. H. PREECE, F.R.S.

(*Read before Section A, August 9th.*)

THE year 1892 has been remarkable in the number and severity of those electric storms which interfere so seriously with telegraphic communication. Unfortunately observations made upon them on working circuits are rarely reliable. Their arrival and departure are sudden; they come when they are least expected, and they occur in busy hours when the wires are fully occupied with more remunerative currents, and when the staff is fully engaged. Their presence, duration and relative intensity are so exactly coincident with magnetic disturbances that the recorded observations in magnetic observatories of needle observations may be taken to indicate the same elements of earth currents also, but they do not give their direction nor their absolute intensity. Their general direction is determined by the simultaneous observation of many circuits running in many directions and noting the lines of maximum and those of no disturbance. This gives the position of the equipotential planes on the surface of the earth, and the intensity of the currents gives the difference of potential between these planes.

I have not succeeded in obtaining definite facts to prove that these planes are perpendicular to the line joining the centre of the earth and the centre of the sun, but there is little doubt that it is so, for telegraph circuits running in this direction experience the maximum disturbances, while those running at right angles on the equipotential planes suffer no disturbance. Those that experience the maximum disturbance in the forenoon are not affected in the evening, and *vice versa*.

The storms commenced on January 4th, and they have been observed at frequent intervals since.

The great storms occurred on February 13th, March 12th, April 24th—27th, May 18th and July 16th.

The intensity of the maximum currents observed in England frequently exceeded ·045 ampère (or 45 milliampères) which much exceeds in strength the working currents. Hence, ordinary telegraph working was paralysed, and we had to resort to metallic circuits and to the use of condensers to maintain telegraphic communication.

The effect of such currents on our railways might be positively dangerous, for they ring bells and reverse the block signals.

·045 ampère on an ordinary iron telegraph wire (No. 8) means ·54 volt per mile, so that the equipotential planes differing by 1 volt would have been placed about two miles apart.

These earth currents, though variable, are always continuous, and give no indication of alternations.

The simultaneous appearance of auroræ show that disturbances on the sun's photosphere, as indicated by sun spots, produce electrostatic and electro-magnetic effects on the earth's surface of enormous magnitude.

The appearance of earth currents is invariably simultaneous over the whole globe.

Observers abroad would benefit science, if they would record the maximum strength, in milliampères, of the currents received, the geographical direction of the terminal earths of the circuits affected and unaffected, the resistance, in ohms, of the circuits on which the currents are measured, and, if they can, to give the times of duration in Greenwich, and not in local time.

Report of the B. A. Committee, consisting of Prof. G. CAREY FOSTER, Lord KELVIN, Prof. AYRTON, Prof. J. PERRY, Prof. W. G. ADAMS, Lord RAYLEIGH, Dr. O. J. LODGE, Dr. JOHN HOPKINSON, Dr. A. MUIRHEAD, Mr. W. H. PREECE, Mr. HERBERT TAYLOR, Prof. EVERETT, Prof. SCHUSTER, Dr. J. A, FLEMING, Prof. G. F. FITZGERALD, Mr. R. T. GLAZEBROOK (*Secretary*), Prof. CHRYSTAL, Prof. J. J. THOMSON, Mr. W. N. SHAW, Mr. J. T. BOTTOMLEY, Mr. T. GRAY, Prof. J. V. JONES, Dr. G. JOHNSTONE STONEY, and Prof. S. P. THOMPSON, *appointed for the purpose of constructing and issuing Practical Standards for use in electrical measurements.*

(*Presented to Section August 9th*, 1892.)

THE work of testing resistance coils at the Cavendish Laboratory has been continued. A table of values found for the coils is appended. The committee have ceased issuing standards in terms of the legal ohm of the Paris Congress. As will be seen from the Table, most of the coils tested are ohms as defined by the resolutions of the committee, and the Electrical Standards' Committee of the Board of Trade. (See B. A. reports, 1890 and 1891.) According to these,

1 B. A. unit = ·9866 ohms.
1 ohm = 1·01358 B. A. unit.

B. A. UNITS.

No. of coil.		Resistance in B. A. units.	Temperature.
Warden Box, 79	No. 1*a*	·99929	17·7°
	„ 1*b*	·99973	17·7°
	„ 1*c*	·99954	17·7°
	„ 10*a*	9·9928	17·8°
	„ 10*b*	9·9947	17·8°
	„ 10*c*	9·9941	17·8°
Elliott, 230	80	1·00016	14·4°

OHMS.

No. of coils.				Resistance in ohms.	Temperature.
Elliott	259	C.L.C.	206	·99744	15·5
„	260	„	207	9·9788	15·6
Nalder	3,059	„	326	·99941	14·5
Elliott	271	„	327	·99805	15·4
„	272	„	328	·99810	15·8
„	273	„	329	·99795	15·4
„	276	„	330	·99811	15·5
„	274	„	331	9·9869	17
„	275	„	332	9·9862	17·1
„	277	„	333	9·9862	17·1
Nalder	3,260	„	334	·99912	14·7
„	3,261	„	335	9·9970	14·5
„	3,058	„	336	·99897	13·9
„	3,265	„	337	·99868	13·9
Elliott	284	„	338	·99870	12·7
„	285	„	339	·99856	12·9
„	286	„	340	·99870	12·8
„	287	„	341	9·9707	12·8
Nalder	3,259	„	342	·99879	13·2
„	3,262	„	343	9·9955	13
Edison-Swan		„	344	9·9945	14·5
Nalder	3,402	„	345	·99971	16·7
„	3,403	„	346	·99967	16·5
„	3,404	„	347	·99970	16·7
„	3,405	„	348	·99960	16·4
„	3,406	„	349	·99960	16·3
„	3,564	„	350	·99962	16·4
„	3,565	„	351	·99957	16·4
„	3,566	„	352	·99960	16·5
„	3,567	„	353	·99949	16·4
„	3,568	„	354	·99961	16·5
„	3,569	„	355	·99964	16·5
„	3,558	„	356	9·9928	15
„	3,557	„	357	99·902	14
„	3,558	„	358	999·09	13·8
Edison-Swan		„	359	·99994	14·4

Of the ohm coils the three first in the table have been tested before (Report 1891) it was thought desirable to reissue the certificates in terms of the new ohm standards. A large number of the other coils were constructed as legal ohms, hence the values of the resistance given in ohms at temperatures of 14° or 15° are low. The coils in many cases are very nearly legal ohms at the temperatures given, while they will be ohms some 8° or 10° higher.

In addition to the coils given in the table, four ohm coils, constructed by Messrs. Elliott Bros., for the Board of Trade, were tested very carefully. Some fourteen or fifteen comparisons were made for each coil at temperatures between 9° and 18°, between June, 1891 and January, 1892. The coils were compared directly with the B.A. unit, "Flat," the difference being expressed in terms of the bridge wire; while in another series of observations a coil of resistance, 100 ohms, was put in multiple arc with the ohm standard, and the difference between flat and the combination found;

in this case the length of the bridge wire used was small, and the possible error arising from uncertainty as to its exact temperature was avoided; that this error was very small was proved by the fact that the two sets of observations gave practically identical results.

The following are the results:—

Elliott	261	... 300	...	$1 - \cdot000309\ (t - 15{\cdot}35)$
„	262	... 301	...	$1 - \cdot000310\ (t - 15{\cdot}35)$
„	263	... 302	...	$1 - \cdot000300\ (t - 15{\cdot}4)$
„	264	... 303	...	$1 - \cdot000312\ (t - 15{\cdot}4)$

In the case of two of the coils, Nos 261 and 263, there was one observation for each, which differed from the value given by the above curve by ·00015 ohms, and this was due to the fact that the ends of the coils had got dirty and needed gamation. None of the other errors in the sixty observations exceeded ·00008 ohms, and there were only eight which were as great as ·00005. Thus the resistances of these coils are known in terms of the B.A. Standard to a very high degree of accuracy.

During the year, Messrs. Elliott Bros. have supplied the committee with two 1 ohm and two 10 ohm standards—the tests of these are in progress; two 100 ohm standards are on order. Messrs. Nalder Bros. are also constructing some standards. The Fleming-bridge, belonging to the Association, has been put into thorough repair; the mercury had damaged some of the copper connecting pieces.

The Secretary and Mr. Skinner have continued during the year their experiments with Clark cells. These have been communicated to the Royal Society, and the paper is being printed in the *Phil. Trans.*

They find that the E.M.F. of their standard cell is 1·4342 volts at 15° C., while cells set up by Lord Rayleigh in 1883-1884, Mr. Elder in 1886, Mr. Callendar in 1886, Dr. Muirhead in 1890, Dr. Kahle, of Berlin, Dr. Schuster, Mr. Wilberforce, Mr. Griffiths, and these in 1891 and 1892, agree closely, the variations among them all being very rarely greater than ·0005 volt.

During the Edinburgh meeting the committee were honoured with the presence of Dr. von Helmholtz, M. Guilleamus, of Paris, Prof. Carhart, of the United States, Dr. Lindeck and Dr. Kahle, of the Berlin Reichsanstalt. These gentlemen came by invitation to consider the question of establishing identical electric standards in various countries, and two meetings of the committee were held, at which discussions took place. Major Cardew, of the Board of Trade, was present, and took part in the discussion. Dr. von Helmholtz drew special attention to the need for having a unit of resistance defined in terms of a specified column of mercury, and pointed out that the difficulty arising from the uncertainty of the relation between the centimetre and the gramme might be avoided by defining the mass of mercury column of given length, which has a resistance of 1 ohm. After discussion, the following resolutions were agreed to:—

1. That the resistance of a specified column of mercury be adopted as the practical unit of resistance.

2. That 14·4521 grammes of mercury, in the form of a column of uniform cross section, 106·3 cm. in length, at 10° C. be the specified column.

3. That standards in mercury or solid metal having the same resistance as this column, be made and deposited as standards of resistance for industrial purposes.

4. That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of a freshly set up mercury column.

It was further agreed that these resolutions should be communicated to the Electrical Standards Committee of the Board of Trade.

With regard to the units of current and of electromotive force, it was agreed that the number ·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of 1 ampère, and the value 1·434 as the electromotive force in volts of a Clark cell at 15° C.

Dr. von Helmholtz expressed his full concurrence in these decisions, which are, as he informed the committee, in accord with the recommendations which have already been laid by the Curatorium of the Reichsanstalt, as well as by himself before the German Government.

The committee wish to place on record their thanks to Dr. von Helmholtz and the other visitors for the help they have afforded them in coming to so satisfactory a conclusion.

Dr. Lindeck laid before the committee some information as to the properties of the manganese alloy used at the Reichs Anstalt for resistance coils, and it was agreed that it was desirable to obtain copies of the German standards in manganin for further comparison with the standards of the Association. The committee therefore recommend that they be reappointed, with the addition of Mr. Geo. Forbes, and with a grant of £25, including an unexpended balance of £10. That Prof. G. Carey Foster be chairman, and Mr. R. T. Glazebrook, Secretary.

APPENDIX I.

INFORMATION CIRCULATED BY THE SECRETARY FOR THE MEETING OF THE COMMITTEE ON AUGUST 4TH, 1892, WITH ADDITIONAL NOTES.

The report of the Electrical Standards Committee of the Board of Trade is printed in the B. A. report for 1891. Further information as to the values of the units is given in the B. A. report for 1890. The following summary may be of use.

The Board of Trade Committee recommended for adoption the values ·9866 and 106·3.

The specific resistance of mercury in ohms is thus:—

$$\cdot9407 \times 10^{4}$$

Also 1 Siemens unit = ·9407 ohms.
= ·9535 B. A. U.

1 ohm ... ... = 1·01358 B. A. U.

The results found by Lord Rayleigh were originally reduced by the use of the value for the specific resistance of mercury in B. A. units found by him. If, instead, we use the value ·9535, the mean of the best determinations, there we have for the length of the mercury column having a resistance of 1 ohm, the values 106·27 and 106·31.

At the meeting of the committee, M. Guillaume stated that a correction should be made to M. Wuilleumeier's value, which would raise it to 106·31. This arose from some uncertainty as to the correction required to the resistance of mercury for change of temperature, a question on which M. Guillaume had been working lately. Taking these corrections and omitting the value found by Prof. Wiedemann in accordance with the criticisms of Prof. Dorn, communicated by Dr. von Helmholtz, we arrive at 106·31 as the mean result.

2.—*The Electrolysis of Silver.*

The following values have been found for the mass of silver deposited from a solution of silver nitrate in one second by a current of 1 ampère:—

I.—THE VALUE OF THE OHM.

Observer, Date.	Method.	Value of B.A.U. in ohms.	Value of 100 centimetres of mercury in B.A.U.	Value of ohm in centimetres of mercury.
1 Lord Rayleigh, 1882	Rotating coil ...	·98651	·95412	106·31
2 „ 1883	Lorenz method ...	·98677	—	106·27
3 Mascart, 1884 ...	Induced current ...	·98611	·95374	106·33
4 Rowland, 1887 ...	Mean of several methods	·98644	·95349	106·32
5 Kohlrausch, 1887 ...	Damping of magnets	·98660	·95338	106·32
6 Glazebrook, 1882 and 1988	Induced currents...	·98665	·95352	106·29
7 Wuilleumeier, 1890...	... ...	·98686	·95355	106·31
8* Duncan & Wilkes, 1890	Lorenz	·98634	·95341	106·34
9† Jones, 1891	Lorenz	—	—	106·31
	Mean ...	·98653	—	106·31
10 Strecker, 1885 ...	(An absolute determination of resistance was not made. The value ·98656 has been used	—	·95334	106·32
11 Hutchinson, 1888 ...		—	·95352	106·30
12 Salvioni, 1890 ...		—	·95332	1. 6·33
12* „ ...		—	·95354	106·30
	Mean	·95354		106·31
13 H. F. Weber, 1884 ...	Induced current ...	Absolute measurements compared with German silver wire coils issued by Siemens or Strecker		105·37
14 „ „ ...	Rotating coil ...			106·16
15 Roiti, 1884 ...	Mean effect of induced current			105·89
16 Himstedt, 1885 ...	... ...			105·98
17 Dorn, 1889	Damping of a magnet			106·24
18 Wild, 1883	Damping of a magnet			106·03
19 Lorenz, 1885 ...	Lorenz method ...			105·93

Mascart, *J. de Physique*, iii., 1884...	... ...	·0011156
Rayleigh, *Phil. Trans.*, ii., 1884 ...	... ...	·0011179
Kohlrausch, *Wied. Ann.*, xxvii., 1886	... ...	·0011183
T. Gray, *Phil. Mag.*, xxii., 1886 ...	... about	·001118
Potier et Pellat, *J. de Physique*, ix., 1890	...	·0011192

Dr. Schuster has shown, *Proc. R. S.*, Vol. l., 1892, that the amount of silver deposited when the voltameter is in a vacuum is about ·04 per cent. greater than when it is in air.

3.—*Clark's Cells.*

The following values have been found for the E.M.F. of a Clark's cell at 15° C. They have been reduced from those given in the original papers on the supposition that 1 B.A.U. = ·9866 ohms, and that the mass of silver deposited per second per ampère is ·001118 grammes.

Rayleigh, *Phil. Trans.*, ii., 1884	... ...	1·4345 volts.
Carhart	... ...	1·434 „
Kahle, *Zeitschrift fur Instrumentenkunde*, 1892		1·4341 „
Glazebrook and Skinner, *Proc. R. S.*, li., 1892		1·4342 „

A comparison has been made between the standards of the association and the Berlin standards through a Clark cell and a resistance coil belonging to Dr. Schuster. By the kindness of Dr. von Helmholtz, the secretary hopes to have a direct comparison between the two sets of standards completed before the meeting (see Appendix III.).

APPENDIX II.

ON THE VALUES OF CERTAIN STANDARD RESISTANCE COILS.

By R. T. GLAZEBROOK, F.R.S.

In the report of the committee for 1890 it was stated that during the early part of the year small changes had taken place in the values of some of the old B.A. standards which had been subjected to a very low temperature early in that year. These coils have been compared together at intervals since that date, and the following tables will

show that at the temperature given there is no indication of any further change. The difference between the coils and the standard coil flat is given in bridge wire divisions. The value of one bridge wire division is about ·00005.

The first few lines in each table give the values of the differences observed in 1890. These are followed by those of the more recent observations which were taken at a temperature of about 16°.

TABLE I.—*Showing the differences between the Platinum Silver B.A. Units in* 1890 *and in* 1892.

Date.	Temperature.	Flat—F.	Flat—G.	Flat—H.
May, 1890	14·4	− 3·5	21·5	18·3
June, 1890	16	− 3·2	22·2	17·8
August, 1890 ...	16·5	− 3	22·6	18
July 23rd, 1892 ...	16	− 3·7	21·6	18·4
July 24th, 1892 ...	16	− 3·5	22	18·3
July 27th, 1892 ...	16·2	− 3·2	21·6	14·3

These observations are sufficient to show that there has been no appreciable change in the relative values of these coils.

The observations on the legal ohm standards given in Table II. lead to the same conclusion.

TABLE II.—*Giving differences in bridge wire divisions between the legal ohm standards and flat.*

Date.	Temperature.	C.L.C. 100-Flat.	C.L.C. 100-Flat.
August, 1890	15·7	216·7	206·6
November, 1890	15	217·2	206·7
January, 1891	11·6	216·1	206·8
July 25th, 1892	16·3	215·6	205·8
July 27th, 1892	16·1	216·0	206·3

In November, 1890, two new coils, marked J and K, were made of platinum-silver wire supplied by Messrs. Elliott Bros. The wires of the coils are wound in a loose spiral inside the case, being secured at intervals by silk threads to an ebonite central stem. They are thus in contact with air only, and there is no paraffin inside the case. It was hoped in this way to secure freedom from the strains set up by changes of temperature in the paraffin which appeared from the results given in the report for 1890, to have some connection with the changes of resistance there described.

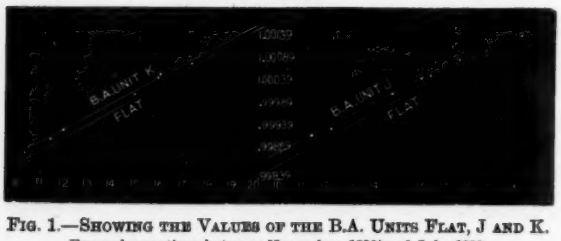


FIG. 1.—SHOWING THE VALUES OF THE B.A. UNITS FLAT, J AND K.
From observations between November, 1890, and July, 1892.

The vertical divisions are ·00005 B.A.U.; the horizontal divisions are 0·1° C. Flat = 1 B.A.U. at 14·8°, temperature co-efficient ·00277 (Fleming's observations, 1876); J = 1 B.A.U. at 14°, temperature coefficient ·00260; K = 1 B.A.U. at 14·15° temperature co-efficient ·00261.

From the six observations for each coil recorded, it is clear that there has been no change during the time for which the observations have lasted.

Two observations were made at a much lower temperature, and these would seem to indicate a slightly less temperature coefficient than is shown by the observations between 10° and 20°

The values of the two new coils in B.A. units between temperatures of 10° and 20° are given by

$$J = 1 + ·000260\ (t - 14)$$
$$K = 1 + ·000261\ (t - 14·15)$$

We may thus conclude that during the past two years there has been no relative change in the values of the platinum silver unit standards of the association.

Four of these are the original standards made in 1865—67, two others were made by Messrs. Elliott Bros. in 1885, and the last two by the Assistant at the Cavendish Laboratory from wire supplied by Messrs. Elliott in 1885.

APPENDIX III.

ON THE VALUES OF CERTAIN STANDARDS OF RESISTANCE AND ELECTROMOTIVE FORCE SENT FROM BERLIN FOR COMPARISON WITH THE B.A. STANDARDS.

Towards the end of July Dr. Lindeck, of the Physikalischi Technische Reichsanstalt, at Berlin, brought to Cambridge three resistance coils of nickel manganese copper alloy, in order to compare them with the B.A. standards.

Experiments to determine the value of these coils in terms of the resistance of mercury are in progress at Berlin. When they are completed a comparison of the B.A. units with the mercury standards of the Reichsanstalt will become possible.

A fourth coil, constructed for the Berlin Reichsanstalt by Messrs. Elliott Bros, was also tested. Table I. contains the results.

TABLE I.

No. of coil.	Date.	Temp.	Value in B.A.U.	Mean value of series.
Wolff 150 ...	July 25	16·5	1·01118*	1·01118 at 16·7°
	„ 27	17	1·01116	
	„ 25	16·5	1·01119*	
	„ 26	16·3	1·01119	
	„ 27	17·1	1·01120	
Wolff 139 ...	July 25	16·5	1·01110*	1·01112 at 16·7°
	„ 27	16·9	1·01112	
	„ 25	16·5	1·01110*	
	„ 26	16·3	1·01114	
	„ 27	17·1	1·01116	
Wolff 147 ...	July 25	16·5	1·01112*	1·01113 at 16·7°
	„ 27	16·9	1·01112*	
	„ 25	16·5	1·01113*	
	„ 26	16·3	1·01112	
	„ 27	17·1	1·01115	
Elliott 250 ...	July 25	17	1·01107*	1·01107 at 17°
	„ 27	17	1·01107*	
	„ 28	17	1·01108	
	„ 29	17	1·01108	

In the experiments marked thus * a considerable length, 200 cm. of the bridge wire, was used. An error of 1° in the temperature of this would produce an error of ·00003 in the result. In reducing the results the temperature of the bridge has been taken as 18° the value given by a thermometer laid along side the wire on July 28th. In the other experiments a coil of 100 ohms was put in multiple as with the Berlin Standard and the difference of the combination and the B.A. Units was found.

The length of bridge wire was very small so that an exact knowledge of its temperature was not wanted while the 100 ohm coil was known with all the necessary accuracy.

Another set of comparisons leading to results which do not differ from the above by more than ·00003 B.A. units, were made by Dr. Lindeck, using apparatus he had brought from Berlin; but a complete discussion of the whole can best be given when the values of the Berlin coils have been found. Dr. Lindeck also brought four Clark cells. Of these two, No. 69 and 71, were of the pattern described by Dr. Kahle, *Electrotechnische Zeitschrift*, July 22nd, 1892. *Zeitschrift fur Instrumenten Kunde*, Ap., 1892. The mercurous sulphate is enclosed in a porous pot, its zinc dips among the crystals of the zinc sulphate, its end being bent so as to be horizontal. The vertical portion of the zinc is covered with a glass tube so that the horizontal part alone is effective. The other two, Nos. 12 and 29, were H cells of the pattern described by Lord Rayleigh.

These cells were compared with the Standard at the Cavendish Laboratory with the results shown in Table II., which gives the differences between the four cells and the standard in hundred thousandths of a volt.

TABLE II.—*Values of Berlin cell. Standard in* ·00001 *volt.*

Date.	July 26th.	July 27th.	July 29th.
Temperature.	16·1	15·9	15·9
Cell No. 69	− 15	− 18	− 14
„ „ 71	− 11	− 15	−
„ „ 29	− 36	− 35	− 36
„ „ 12	− 39	− 38	− 39

On July 29th, cell No. 71 had been taken away.

Dr. Kahle kindly determined the differences between No. 69 and each of the other cells before they left Berlin. Values for these same differences can be obtained from the above Table II.

We thus get Table III.

TABLE III.—*Differences between Cell* 69 *and the others sent from Berlin.*

Date and place of observation.	No. 71.	No. 12.	No. 29.
July 19th, 1892, Berlin ...	− 2	29	29
„ 20th, „	− 4	28	25
„ 21st, „	− 4	25	26
„ 26th, „ Cambridge ...	− 4	21	24
„ 27th, „	− 3	19	20
„ 29th, „	...	22	25

Thus the relative values of the cells as found at Cambrfdge are practically the same as those found at Berlin, while taking the E.M.F. of the Cambridge standards as 1·4342 volts at 15°, that of the Berlin cells with porous pots is 1·43405 and of the Berlin H cells about 1·4338.

The value actually found by Dr. Kahle for the E.M.F. of the porous pot cells is 1·4341 volts, so that the agreement is complete. In all the above it has been assumed that the resistance of 106·30 cm. of mercury is 1 ohm, and that the amount of silver deposited per second by a current of 1 ampère is ·001118 grammes.

The H form of cell in all cases examined at Berlin has a slightly lower E.M.F. than those with the porous pots the difference being about ·0003 volts.

APPENDIX IV.

ON THE STANDARD CONDENSERS OF THE ASSOCIATION AND ON CERTAIN RESISTANCE COILS.

By R. T. GLAZEBROOK, F.R.S.

The report of the committee for 1890 contains as an appendix a very full account of the tests on the standard condensers belonging to the association. It was there stated that while the insulation resistance of No. I. was very high, that of No. II. was not completely satisfactory. No. II. was, therefore, taken to pieces and set up fresh. Its capacity, and also that of No. 1., were determined afresh, using the commutator method described in the previous paper.

The following values were found:

CONDENSER No. 1.

Date.	Capacity in microfarads.	Mean of each series.
December 23rd, 1890	·021059	·021050
" " "	·021052	
" " "	·021046	
" 29th, "	·021044	

CONDENSER No. II.

December 23rd, 1890	·021396	·021395
" " "	·021392	
" " "	·021399	
" " " afternoon...	·021365	·021389
" " " " ...	·021399	
" " " " ...	·021403	
" 29th "	·021381	·021390
" " "	·021409	
" " "	·021389	

Mean of the whole ... ... ·021391 microfarads.

The different values in each series correspond to different rates of revolution of the commutator.

The value found originally for the capacity of No. I. was ·021024 microfarads; it would appear, therefore, that it may be slowly increasing. The capacity of No. II. has been changed by being taken to pieces, and from ·022515 to ·021391.

The two condensers were also compared directly assuming the value of No. 1 to be ·021050, that of No. II was found to be ·021390, practically the same value as that given by the commutator.

As a further check on the values a mica condenser was compared with the two in the usual way. The values found were:—

Date.	In terms of I.	In terms of II.
December 29th, 1890	·5017	·5013
January 1st, 1891	·5013	·5012

In March, 1892, the insulation of the condensers was tested by the secretary and Mr. A. S. Bowley; they were both found to lose rather less than $\frac{1}{1000}$th of their charge per 1 minute

A divided condenser, Elliott No. 144 C.L.C. No. 3 was compared; the results are interesting as showing the effect on the capacity of the time of charging and are given in Table III.

The first observation in each case marked as 0″ was made by connecting the galvanometer and then momentarily making the battery circuit for a very small fraction of a second. The observations on the condenser, ·2, show that there has been no appreciable change in the relative value of the Standards I and II. The observations throughout are accurate to about one part in 10,000.

During the process of the work, Mr. Bowley compared several of the resistance boxes of the association together; as these are used as standards in many experiments, it will be useful to put the results on record.

Box-Elliott 1,253 is a Wheatstone's bridge box of platinum silver in legal ohms, said to be right at 18°. Assuming that the two 1,000 ohm coils of the bridge are equal, and the experiments showed no appreciable difference. The following values were found for certain coils in terms of a nominal 10,000 ohms taken from 1,253.

TABLE III.

Nominal value.	Time of charging.	Value in terms of I.	Value in terms of II.
·05	0″	·05022	
	5″	·05072	
	10″	·05080	
·05	0″	·05055	
	5″	·05106	
	10″	·05109	
·2	0″	·1988	·1981
	2″	·1999	·2002
	5″	·2007	·2009
	10″	·2010	·2013
	20″	·2012	
·2	0″	·2003	
	2″	·2018	
	5″	·2027	
	10″	·2033	
	20″	·2039	
	30″	·2046	
·5	0″	·5032	
	2″	·5058	
	5″	·5078	
	10″	·5081	
	20″	·5092	

ELLIOTT, 1,825.		NALDER, 1,870.	
Nominal value.	Value found.	Nominal value.	Value found.
10,000	10,012	100,000 No. 1	100,042
20,000	20,024	" No. 2	100,044
30,000	30,034	" No. 3	100,050
40,000	40,049	" No. 4	100,034
		" No. 5	100,042
		" No. 6	100,042
		" No. 7	100,052
		" No. 8	100,032
		" No. 9	100,047
		" No. 10	100,052

The temperature of all the coils was about 15·6° C.

Thus the box Elliott, 1,825, is right at about 4° below the box 1,253, while the box Nalder, 1,870, is right at about 1·5° below 1,253.

At the conclusion of the report of the committee,

The PRESIDENT invited Prof. von Helmholtz to give the opinion held by the German authorities on the English standards.

Prof. VON HELMHOLTZ said they in Germany were in the same position as the English scientists. At the congress of 1884 it was determined that the French Government should bring the decision of the congress before the European Governments, asking them to legalise the standards adopted in each country. As far as he knew the communication of the French Government had been made, but no steps had yet been taken. At the time of the 1884 congress few measurements had been made, and several delegates undertook to make new measurements, the results of which were brought before a later congress. They had then to choose between figures which had a difference of 1 per cent., and they chose the proposal of Dr. Werner Siemens, which was the mercury column, one square millimetre in section, and 1 metre 6 centimetres in length, at a temperature of freezing point. That was the most accurate number they could then arrive at. Since then the work had been continued by Englishmen, Frenchmen, and Germans, and their conclusions were more in agreement; and they could take it for granted that 106·3 was right to about $\frac{1}{1000}$th part of the whole. This value was quite sufficient for all industrial purposes, and it would be found of sufficient accuracy for most scientific purposes. There was, therefore, no reason to retain the former definition of the Paris congress. In April of this year they, in Germany, brought the result of their experiments before the consulting committee; about that time they received information of the English proposals, and then found it was quite sufficient to accept the proposals of the British Association Committee, which had been laid before the Board of Trade. There were only minute points on which they thought there could be any difference. The speaker's experiments, as well as those of others, showed that solid wires were very uncertain, and liable to alteration. For higher resistances they had used German silver, and they had found that this alloy, like many others, changed its resistance. If such a wire was wound round a coil it had a larger resistance than before, and altered within some weeks; they were never sure that wires, which had at first the same resistance, were still the same after some months had elapsed. They had tried other alloys which had a very low temperature

coefficient, and with these it was possible to get a fair degree of accuracy. It was found that an alloy, principally consisting of nickel and copper, had a very small temperature coefficient and had at the same time good mechanical qualities; so that if a new coil had been wound and heated several times in boiling water, one could get it in a state in which there would be no change. Such coils when compared with mercury standards had been found to be unalterable during the space of a year. The British Association wires which were made of platinum, silver, and several alloys showed good constancy, except two which had been frozen, seemed to suffer some modifications in their interior, perhaps some fissures had developed which, failing to close again, would permanently alter the resistance. While a great number of these resistances might remain unaltered, it would be different in the case of a wire coil which had been used as a standard for centuries, for anyone to look into the interior to ascertain if there had been any alteration. They were, therefore, of opinion that it would be better to keep up the old definition of the resistance given by Dr. Werners Siemens of the mercury column. They, in Germany, had made many accurate experiments with the mercury column. One of his (the speaker's) assistants had found out some new errors which hitherto had not been observed. Such a mercury column placed in a narrow tube, then, again, placed in a thick tube of glass and surrounded by iced water, became heated to one-third of a degree which was sufficient to alter the resistance, but that alteration could be measured; it was even possible to measure the degree of conductivity of the glass tube for heat by observing that little alteration of temperature. They must suppose that all the observations of the resistance of mercury hitherto had been a little too high, and that one must take care of these alterations. A curious thing in filling these tubes was the influence of capillary force. It was demonstrated that the mercury did not completely touch the glass tube if it was not filled in a vacuum. An easier way of filling was to place a drop of petroleum between the mercury and the glass, the mercury and glass then making better contact; they got less resistance from such a column of mercury than when the ordinary methods of filling were adopted. He thought that the value of the smallest resistance was probably right, for a higher resistance showed that the filling of the tube was not completed. That was a reason why the square section of the mercury column should not be defined by length, for no one could measure with absolute accuracy the internal diameter of a glass tube of a square millimetre section. It seemed better to define the square section of the mercury column by weight. As far as it was possible to make out, the English standards were in so good an agreement with the independently made standards of the Germans, that there was no reason to be divided on the question. For industrial purposes, the accuracy obtained was quite sufficient, he might say, for centuries. For scientific purposes, there would perhaps be some alteration necessary, but that was a question of time. Scientific people, who had a good definition of the standards they employed, could make the little calculation necessary to reduce them to their requirements. He thought that all nations were very near an agreement. They had been sent by the German Government to try to come to an agreement with England, and he hoped that America and France would come into the same agreement with them all.

ELECTRIC LIGHTING ACTS, 1882 AND 1888.

THE following is a copy of a letter from Sir Courtenay Boyle, of the Board of Trade, addressed to the London County Council on 13th inst.:—

Sir,—With reference to previous correspondence on the subject of the approval by this Department of the pattern and construction of electricity meters for the purposes of electric lighting orders, I am directed by the Board of Trade to inform you that, having carefully considered the several patterns of meters which have been submitted for their approval, they are of opinion that it is desirable that they should have further experience of the practical working of the meters in actual use before any formal approval is given.

Though some of the patterns of meters which have been submitted have many merits, and the laboratory tests which have been applied have been, in several particulars, satisfactory, no meter has shown such perfection in principle, design and construction, as to justify the Board of Trade in the conclusion that serious defects might not appear in actual working.

Under these circumstances, the Board of Trade are of opinion that further experience of the behaviour of meters should be gained, and possibly further enquiry made, before the final decision of the Department is arrived at. Representations, moreover, have been made to them with regard to the effect on the interests both of those who are engaged in supplying electrical energy and of those whose efforts are being continuously directed to the invention of meters which would be produced were any approval, even of a temporary and provisional kind, to be given now to any particular pattern or patterns of meter.

With the view of acquiring as fully and as thoroughly as possible information as to the behaviour of meters under working conditions, the Board of Trade would be glad of the co-operation of the London County Council in providing for a thorough practical test, and they would suggest that the council should, at their earliest convenience, instruct their representative to confer with Major Cardew, the electrical adviser of the Department.

Pending the acquisition of this information, which they anticipate will occupy a period of about 12 months, the Board of Trade are not prepared either to approve the pattern and construction of any electricity meter not yet approved, or to further extend the approval already given in the case of the Shallenberger meter, which has been approved for the purposes of the following Act and Orders only, namely:—

The Metropolitan Electric Lighting Act, 1889; The Metropolitan Electric Supply Company (West London) Lighting Order, 1889; The Metropolitan Electric Supply Company (Mid London) Lighting Order, 1889; The Metropolitan Electric Supply Company (Paddington) Lighting Order, 1890; The House-to-House Electric Light Supply Order, 1889."

THE COLLIER-MARR TELEPHONE COMPANY.

THE Collier-Marr Telephone and Electrical Manufacturing Company, Limited, is formed for the purpose of acquiring the patents and property of the Collier Audible Telephone Syndicate. The patents cover the Collier receiver and the Collier-Marr transmitter; the property comprises works, plant, machinery, stock-in-trade, and effects. The nominal capital is £100,000; the present issue, £75,000; the purchase price of the rights and property acquired, £51,500 (£4,000 in cash, £25,000 in shares, and the remainder in cash or shares, according to circumstances). "The works have been fitted up with suitable plant and machinery," but the value of it is not stated, and as "the vendors have hitherto chiefly confined their operations to perfecting their instruments, and to submitting the same to very thorough tests," it would appear that manufacturing has not been carried on upon a large scale. In the absence of any valuation of the works and property, we may assume that the patents represent the bulk of the amount paid to the vendors.

The principal patent is that for the Collier receiver, and the great feature of the Collier receiver is that it uses both ends of the electro-magnet, "which is an integral part of the instrument," the serious defect in existing systems being "chiefly owing to the wasteful method of employing one end only." The transmitter has no superlative merit claimed for it, but it is an "improved" transmitter, "which, used in combination with the receiver, will, it is believed, be of great advantage," and, presumably when so combined, "it is claimed by the patentees that the instruments made under their patents are so superior to any hitherto invented, that it will be difficult for any telephone exchange company to successfully compete, unless it adopt this company's instruments."

The beautiful invention of Prof. Bell remains very much what it was when first introduced in its commercial form. Slight improvements have been made and slight improvements only. But there has been no lack of attempts. One of the first was to increase the number of diaphragms in the expectation that increased power would result. But Bell telephones with multiple diaphragms were early discarded. We cannot now discuss the reasons, but we may suggest the probability that the direct action of one diaphragm is superior to the necessarily indirect action of two or more. Any advantage which may result from the use of the two ends of the electro-magnet as in the Collier telephone, is governed by the utility of two diaphragms, and, according to previous experience, there is no utility in two diaphragms. Inventors before Mr. Collier have used not only two, but twice two, diaphragms, and have just as confidently expected that their instruments would have to be employed by every exchange company which wished to continue in existence, but the test of practice tended to show that the use of any diaphragm in excess of one is "wasteful."

Printed in large type and red ink at the head of the prospectus, is an extract from a report by Mr. W. E. Heys, M.I.E.E., Manchester, stating that "the electrical efficiency of your instruments is much more than ten times that of the best instruments which I have hitherto tested." To assess the relative merit of different telephones is a delicate and difficult task. There are few testing operations requiring more thorough care and none in which the "personal equation" needs to be more considered. The report, printed in full with the testimonials, is simply nonsense, and the extract quoted in the prospectus most misleading. Will applicants for shares understand that the Collier Telephone is ten times better than the other best because Mr. Heys says its

"electrical efficiency" is ten times more? And if they should so understand, whose fault will it be that they are misled? They cannot be expected to know what is meant by the "electrical efficiency," or to understand that the method by which the result quoted was attained has no relation whatever to the conditions of actual use. Most of the testimonials are absurd, yet are calculated to mislead those who are not practical electricians. One or two of the testimonials indicate that the Collier telephone is a practicable instrument. We have no desire to give any other impression, or to detract from any merits it may have. The demand for telephones should grow, and there should be a reasonable chance for any new type that can hold its ground in price and quality with the numerous others which are now obtainable, or may in the future be obtained; but the commercial chances of the Collier telephone are not improved by the exaggerated claims made for it, or the circulation of the absurd reports made upon it. The price at which it can be sold must, of course, be largely governed by the capital upon which a dividend has to be paid, and the proportion which is invested in the production, as compared with that which is unproductive. We have no hesitation in saying that if the Collier telephone were ten times as good as it is claimed to be, it would not justify such an apportionment of the issued capital as £51,500 to the vendors, and £23,000 for extending and carrying on the business. Such an apportionment leads to the impression that the company is merely a promoter's company.

Though we hope that investors will have considered such points as these, we cannot overlook the fact that such companies are subscribed to. There is a psychological moment for the issue of prospectuses of a certain class. It is immediately following the successful flotation of a company bearing a somewhat similar title. There should just now be a demand for any telephonic patent which can have something claimed for it, and will enable the vendors to fix the price for re-sale to a public company. If there should be no new inventions, we may expect that some genius will re-discover the possibility of carrying on a conversation with two tin cans and a piece of string, thus avoiding the wasteful method hitherto in use in the employment of magneto- or volta-electric currents. With such a prospectus before us it is clear that the danger is a real one. Our readers may do some good by assisting to disseminate the information that the original patents on telephones have expired, that telephones are now articles of general commercial manufacture, and subject to the usual laws regulating prices; that any patents must necessarily be for details or improvements only, and that these, although possibly of considerable value, cannot afford the same large profit as an original controlling patent sometimes makes possible. If the company is considered as a manufacturing concern apart from the value of the patents, it is only necessary to remark that it is without experience, and has only one-third of its issued capital available for the purpose.

Electric Lighting at Brighton.—At a recent meeting of the Brighton Town Council, the Lighting Committee submitted a statement of accounts in respect of the Corporation Electric Lighting undertaking for the period from September 15th to December 31st, 1891. From the revenue account it appears that the expenditure had been—for generation of electricity, £391 18s. 10d.; for rates and taxes, £8 6s. 8d.; management expenses, £173 3s. 6d.; insurance, £8 16s. 10d.; reserved for bad debts, £7 9s. 4d., making a total of £589 15s. 3d. The receipts had been—by sale of electricity, £831 10s. 3d., and by meter rents, £8 5s., leaving a balance of £250, which is carried to the net revenue account. A sum of £290 18s. 6d. had to be paid in interest on the money borrowed in respect of the undertaking, and also £242 12s., appropriated in respect of the sinking fund. These two sums created a deficiency of £283 10s. 6d., which it was proposed, in accordance with the provisions of the Brighton Electric Lighting Order, 1883, to charge upon and pay out of the general district rate. The capital account amounted to £37,520 15s. 5d. After some discussion the report was passed.

NOTES.

The Varley Testimonial.—The long expected circular letter is now being sent out, and we hope the response to the appeal for subscriptions will be a hearty one and worthy of the object. The committee is thoroughly representative and strong, as the following names sufficiently indicate, so we trust that recipients of the circular letter will keep it before them and subscribe to the fullest extent of their means. A capital beginning might be made by the larger firms putting down their names each for a substantial sum, this would give the matter a good start, and prevent that waiting amongst the rest to see what others of the same status give before contributing themselves. The iron is hot, and it only remains for Mr. Varley's sympathisers to smite right strongly.

Committee.— Lord Kelvin, Sir Leppoc Cappel, Sir F. Bramwell, Sir H. Mance, Sir J. Pender, Sir D. Galton, Sir D. Salomons, Prof. Ayrton, T. O. Belshaw, G. Binswanger, R. E. Crompton, D. de Castro, D. Fitzgerald, Prof. G. Forbes, T. E. Gatehouse, Dr. Gladstone, W. T. Goolden, J. E. H. Gordon, W. A. Gorman, R. K. Gray, Prof. D. E. Hughes, Dr. J. Hopkinson, R. C. Jackson, Prof. Kennedy, Prof. O. Lodge, E. Manville, W. H. Massey, H. Mavor, Major Flood Page, T. E. Parker, Prof. J. Perry, W. H. Preece, F. L. Rawson, A. Siemens, A. Slatter, A. Stroh, J. W. Swan, Prof. S. P. Thompson. Hon. secretary, R. E. Crompton; hon. treasurer, A. Stroh.

Proposed Electric Lighting at Chesterfield.—At a recent meeting of the Chesterfield Town Council, an electric lighting committee was formed, consisting of the chairmen of the various committees of the council. A provisional order is to be applied for.

Note the Difference.—The General Purposes Committee of the Walsall Town Council have reported that 28 tenders for lighting part of the borough with electricity have been received. The tenders range from £6,712 to £22,733. The Electric Lighting Sub-Committee have been authorised to visit five or six towns for obtaining information on the subject of electric lighting.

Fatal Accident from Electric Wires in New York.—A week or two ago, says the *Western Electrician*, a man was killed by the electric current at Rochester, N.Y., and the coroner's jury returned a verdict as follows:—"We find that Edward A. Twist came to his death by coming in contact with a wire of the police patrol system, the said wire having fallen across the trolley wires of the Rochester Railway Company on Mt. Hope avenue, on the evening of July 15th, 1892, thus conveying the electric current which caused his death." The verdict of the coroner's jury, says our contemporary, was a complete surprise. It was the first time on record that an electric railway was charged with the death of any person by reason of contact with the trolley wire. Moreover, the evidence reported before the coroner's jury did not seem to warrant such a broad condemnation.

Electrical Engineer Drowned.—An inquest was held at Farndon, last week, on the body of Frederick M'Master, 24 years of age, electrical engineer, of Birkenhead, who was drowned in the Dee, near Chester, whilst bathing. Evidence was given to show that the deceased, who, in company with several Birkenhead students, was camping out on the river bank for a week, went out in the river to bathe, when he suddenly sank, it is supposed through a fit. A verdict of accidental death was returned.

Electrical Engineer for Dundee.—The matter of the appointment of an electrical engineer was very fully discussed at last week's meeting of the Dundee Gas Commissioners. Ultimately, when the matter was put to the vote, there were 12 in favour of Mr. Brownlee (a local engineer) and four in favour of Mr. C. H. Yeaman. Mr. Brownlee was therefore appointed at a salary of £200 per annum, his whole time to be devoted to his duties. Mr. Brownlee acquired his theoretical knowledge under Prof. Ewing at the Dundee University College.

Telegraphs in India.—The Indian Telegraph Department have recently successfully laid three further cables across the River Irrawaddy.

Overhead v. Underground Wires in New York.—During the month of June last the New York Board of Electrical Control reports that 62 telegraph poles and 191 miles of wires were taken down in that city, being replaced by underground wires.

Electric Boats on the Seine.—Messrs. Woodhouse and Rawson have just launched upon the Seine, at Asnières, an electric boat, *L'Eclair*. Its first trip was made on August 9th, in the presence of the Parisian electrical press. This boat is 11 metres long, 1·8 m. wide, and has a draught of 0·4 m. It contains two batteries of 20 accumulators of 160 ampère-hours, and a 3 horse-power motor. The accumulators are all connected in series (80 volts, 30 ampères), for the express speed of 12 kilometres an hour. They are connected in quantity for lower speeds. The boat is constructed to hold 20 persons. The charging is effected at the accumulator station at St. Ouen.

Leeds Association of Engineers.—The annual summer excursion of the Leeds Association of Engineers took place on Wednesday, August 3rd, the members visiting the works of Messrs. Walker and Hall and Messrs. Joseph Rodgers and Sons, Limited, Sheffield. In the morning they were conducted round the former establishment by Mr. C. H. Bingham. This is said to be one of the largest electro-plating works in the world, over 700 hands being constantly employed. The plating and gilding rooms were especially interesting. At one end of these rooms, George Walker, the founder of the firm, first commenced business. It was he who assisted the inventor, Dr. Wright, surgeon, of Attercliffe (now a part of Sheffield). George Walker was the first man who plated any goods for use. The small vat in which he plated these is to be seen in the large show-room, and is valued by the firm at more than its weight in gold. The oldest proprietor remembers the time when, instead of dynamos, which are now used to produce the electrical current which drives the silver on to the goods, cellars full of "Daniell's batteries" were used, and a man in rags (so great was the destruction of his clothing by the acids) worked the batteries.

Miner's Lamps.—Colonel Engledue, late of the Royal Engineers, has patented a miner's improved electric lamp, comprising a cheap electrolytic fluid and primary battery, to which the lamp is attached. The battery is of very simple construction, consisting of a wooden case having a middle partition forming two cells. These cells are lined with lead, to each of which are attached four carbon plates, thus bringing the carbons and lead into electrical circuit. The top of the battery is hermetically sealed by an india-rubber washer, over which an ebonite cover is tightly screwed into the wooden case. Two ebonite plugs are screwed into and through the ebonite cover, through each of which a round zinc element is secured by a simple contrivance, all being made tight by rubber washers to prevent leakage when the battery is reversed. Contacts with the incandescent lamp are made in the usual manner, and the lamp is protected by a small lantern with reflector. The battery is charged to within about an inch of its top with 14 ozs. of the patent electrolytic fluid, 7 ozs. per cell, and after working for four hours, when a proportion of the zinc and also the strength of fluid is somewhat exhausted, the battery is reversed, thus giving the increased area of the hitherto untouched zinc to be attacked by the somewhat weakened solution, the effect being that the electromotive force of the battery is sufficiently sustained for a further period of six hours, making a total of 10 hours' working. In order that the battery shall swing properly when its centre of gravity has been altered by reversal, a special and simple arrangement of handle has been designed which has the desired effect. Colonel Engledue's principal claim that his apparatus will give a useful light for 10 hours is quite justified, for we have on two occasions run it continuously during a much longer period. The light is said by those who know to be sufficient for colliery purposes, so we have much pleasure in calling attention to the merits of the improvements effected.

Chertsey Lighting.—Complaints having been made at last week's meeting of the Chertsey ratepayers, it was resolved that the inspectors be instructed to make enquiries as to the terms upon which the electric lighting company would light the district.

Proposed Electric Tramway in Nordhausen.—The General Electricity Company of Berlin, has laid before a meeting of the Nordhausen Municipality, details of the scheme for the construction of an electric tramway in that town. The project has been favourably received.

Maidstone and Electric Lighting.—The Maidstone Local Board at their next meeting will be asked to appoint temporarily an electrical engineer to superintend the installation of the electric light. It is probable that a lighting station will be shortly erected in the Fair Meadow at an expenditure of from £10,000 to £12,000.

Loan for Bristol Electric Lighting.—An inquiry was held on Friday, at Bristol Council House, by Mr. Rienzi Walton, Local Government Board inspector, with reference to the application of the City Council for sanction to borrow £66,000 for purposes of electric lighting. The Town Clerk explained that the works were to be carried out under the Bristol Electric Lighting Order, 1883, and the money they desired to borrow was required to provide a central station. The inspector asked if it were the intention of the corporation to make electric lighting general in the city if it proved successful. The Town Clerk replied that in the interests of the public they would probably do so. Mr. Preece, electrical engineer, added, that it was proposed that the central station should ultimately be sufficiently large to serve the whole district. At present they were only preparing to provide for the compulsory area. The inspector's decision will be communicated to the council in due course.

Impartiality of the Press.—Our much read contemporary, *Invention*, in last week's issue, refers to an exposure made recently by Dr. Potter in a report which appeared in the *British Medical Journal*, proving the Mattei "cure" for cancer to be a complete fraud, and our contemporary fully endorses the remarks of that medical journal, that "this affords only one more instance of the extraordinary credulity of the mass of mankind and the facility with which they accept the most outrageous statements of ignorant quacks." It is, however, just a little strange to note that such a well-known journal should give prominence to a matter appearing in the *British Medical Journal*, and utterly ignore the fact of the revelations recently made in our own and so many of the other technical journals in regard to the still more notorious electropathic belt trial. But, perhaps our quasi-technical contemporary thinks that the "extraordinary credulity of the mass" is likely to be diminished when its readers see in its own columns an advertisement asking them to try the marvellous curative efficacy of Harness's electropathic belt, recommended by the highest (*sic*) medical and scientific authorities.

Sir G. Dibbs and the Trans-Pacific Cable.—A *Financial Times* telegram from Ottawa, on 13th inst., reads as follows:—"Sir George Dibbs said in an interview with a Press representative prior to his departure:—'I came to Ottawa to see the Premier, Mr. Abbott, in order to obtain his views and those of the Canadian Government on the question of closer trade relations between Canada and Australia. A large trade might be done between the two countries, and the trade now going to San Francisco might be secured to Canada and be a benefit to the Empire if we could communicate directly with Australia through British territory. It would be a grand thing for the Colonies to have a cable entirely laid and connected through British territory in case of war. The proposal was made six months ago by Mr. Coutte, on behalf of the French or English syndicate, to construct a cable from Queensland Port to New Caledonia, which would be the first chain in the link of the Pacific cable to Victoria *via* Fiji, Samoa, and Honolulu. I arranged with Mr. Coutte that New South Wales would contribute £2,000 annually towards the New Caledonian line, and Queensland has arranged to contribute £4,000.'"

Siemens and Halske in America.—With reference to our recent notes regarding Messrs. Siemens & Halske's intention to open works in America, we now learn from our contemporary, the New York *Electrical Review*, that the firm have commenced work on their American plant at Chicago. The stone foundations are set, and the brickwork of the buildings has been commenced. The site alone is said to have cost over $200,000.

The Bath Council and the Electric Lighting Company.—At a meeting of the Bath Town Council last week, it was stated that the inspector had reported that the public lighting had been satisfactory. The resolution of the council, passed on the 21st April last, "That the company be called upon to give the maximum light by the substitution of efficient globes," was communicated to the company, who expressed their intention to carry out the wishes of the council, and in pursuance of the opinion of the inspector, that the Pearline globes caused the least absorption of light of any globes, they have been provided for all the public arc lights in the district. On the recommendation of the committee, apparatus is to be provided to enable the inspector to test meters prior to giving a certificate.

Chatham Electric Lighting.—A committee has been appointed by the Chatham Town Council to consider and report upon the desirability or otherwise of purchasing the Chatham Electric Lighting Company's interests and works.

Communication with Lighthouses.—The Royal Commissioners appointed to enquire into the question of electrical communication between lighthouses and lightships and the shore, left Euston last Monday for Liverpool, where, in company with the Mersey Harbour Board, they were to inspect the various lights in and around the port. The Admiralty yacht, *Enchantress*, sailed from Portsmouth on the same day for Pembroke, to embark the Commissioners on their arrival at that place.

Fatal Electric Lighting Accident in Melbourne.—The Melbourne correspondent of the *British Medical Journal* writes as follows regarding the recent fatal electric lighting accident in that city:—"We have had our first electric light accident. During a thunderstorm a wire broke, and falling across a road was caught hold of by a man, who began to roll the loose end up to place it out of the way. While doing this, as long as the wire was insulated, he felt no effect, but as soon as he came to the broken and exposed end his hand clung to the wire, and he found it impossible to tear himself away. He screamed with pain, and a bystander goodnaturedly came to his rescue, and, catching hold of him with both hands was on the point of trying to tear him away, when he fell dead at his feet. After a few seconds more of intense agony another bystander rushed up with an axe and cut through the wire. The first man, although able to appear at the inquest, is still suffering severely from the shock."

Incandescent Lamp Manufacture.—A Correction.—Mr. C. J. Robertson writes as follows:—In my letter appearing in the Electrical Review for August 12th, on page 211, last line, an error has occurred. Instead of the words "to the 2 C.P. stated, that, say," &c., it should read, "to the 2 C.P. standard, than say the right," &c. It would perhaps have been simpler to state, "The thicknesses of the two sides of such a block photometer do not alter their ratios as demanded by the varying ratios on the photometer bar."

Electric Lighting in the West End.—Mr. Bax, of the Westminster Electric Supply Corporation, has written us regarding the total extinction of the electric light at the St. Stephen's Club, on the evening of the 9th instant. He asks us to contradict a report which has gained ground to the effect that the extinction was due to a failure of supply by the Westminster Corporation. The misapprehension is due to the fact that the club in question having been lighted for some months, and that without any interruption whatever, by current supplied by that corporation, until about six weeks ago, when the committee of the club decided to avail themselves of an offer from another source at a cheaper rate, with the result above stated.

"The Broken Melody."—To those of our readers who are compelled to remain in town and who find the evenings hang heavily on their hands, and also to country subscribers arriving in London, we would advise a visit to the Prince of Wales's Theatre. A technical paper cannot devote the space necessary to enunciate the plot of "The Broken Melody," so we content ourselves with saying the piece is well written and highly interesting, the situations alternately tragic and serio-comic, and the acting throughout excellent, in one or two instances exceptionally fine. The chief point of interest, however, centres in the principal character, a Polish musician, personated by M. Auguste van Biene, the famous violoncello virtuoso, who, well known for some years past as a theatrical *entrepreneur*, here makes his first appearance before London play-goers as an actor. In each of the three acts his beloved 'cello is brought into requisition, and never, we imagine, has the power of music made itself appeal more forcibly to the feelings of his listeners. Such exquisite tenderness, such passionate warmth, such wonderful command of expression and *technique*, simply hold his audience breathless and spellbound. The musical director, too, is to be congratulated on placing amongst the incidental music such an example of high art as the "Reverie" of Vieuxtemps, although an orchestral arrangement, well played as it was, does not enhance the extraordinary beauty of the theme as originally composed for violin solo. We have noticed that some of the daily papers mentioned "The Broken Melody" in no very enthusiastic terms, but the average dramatic critic can rarely see anything good in a play which is an innovation and which he cannot treat of from the purely theatrical standpoint. We wish every success to Mr. Van Biene and his talented company, and trust that his venture will bring him crowded houses, for he has most happily embodied the combined attractions of theatre and concert room in one. We may add that the house is very prettily lighted with incandescent electric lamps, and on the very hottest day yet experienced in London we enjoyed comparative coolness during the evening within the walls of this charming little theatre.

Personal.—The Queen has been pleased to approve the appointment of Sir John Pender, K.C.M.G., M.P., to be G.C.M.G. in the most distinguished order of St. Michael and St. George.

The Lane-Fox Case.—In our last issue we briefly recorded the judgments in the Court of Appeal; in our present pages we give them in full. That of Lord Justice Lindley is a model in every respect, and appears to us to place the matter in exactly the true light.

Electric Lighting of Southport. — The scheme and plans for the electric lighting of Southport, prepared by Mr. Geo. Wilkinson, M.I.E.E., of London, involving the expenditure of £28,000, exclusive of land values, were unanimously adopted by a special Town Council meeting held here on Tuesday last. The system adopted is the high-tension alternate current, and the generating station is to be erected on a site adjoining the present gasworks, 1½ miles out of town. Special provision is being made in the generating station for burning refuse fuel from the gasworks, and water is available for condensing. With these economies, and the advantages to be derived from working the gas and electric lighting businesses together, the actual cost of producing the electrical energy is expected to be very low. Trunk mains (in duplicate) will be laid to transformer sub-stations in the town and residential district of Hesketh Park, where low-tension distribution mains will be laid. The full equipment of the station will be as follows:—Three sets (horizontal engines and dynamos), each equal to an output of 100 units; two sets of 50 units each, and one of 25 units; separate exciters will be used, and alternators worked in parallel. The buildings are very substantial and of good elevation, providing an engine room 100 feet by 40 feet, covered by single-span iron girder roof, and commanded by an overhead traveller. Behind the engine room is the boiler-house, 63 feet 6 inches by 44 feet 6 inches, covered by a roof in two bays. A test room, office, and store room are also provided, abutting on the end of boiler-house. A railway siding to the boiler-house is also provided. It is proposed to supply electric current to consumers at a charge of 6d. per unit, until the profits justify a reduction.

Electric Lighting at Prescot.—The town of Prescot which has hitherto been lighted by gas is now to be illuminated by electricity instead. A tender of the British Insulated Wire Company submitted to a recent meeting of the Local Board was accepted on Tuesday last. It is proposed to erect 10 arc lamps of 2,000 C.P., 2 arc lamps of 500 C.P., and 70 incandescent lamps of 12 C.P. Mr. Yeaman, engineer to the British Insulated Wire Company, stated that they could start lighting the district near the works immediately, and by the middle of next month (September) have the whole district lighted.

New Form of Air Leyden.—The folowing should be interpolated between the two last paragraphs of Lord Kelvin's papers which appeared in our issue of August 5th. "The preceding statement describes the arrangement which is most convenient when the capacity of the cable exceeds the capacity of the Leyden. The plan which is most convenient in the other case, that is to say, when the capacity of the cable is less than that of the Leyden, is had by interchanging B and J throughout the description. In this case, a charge given to the Leyden is divided between it and the cable. The capacity of the cable is then found by the analogy: As the excess of the first reading of the electrometer above the second is to the second, so is the capacity of the Leyden to the capacity of the cable."

University College, Bristol.—The calendar of the College is now ready for the coming session, which commences in the first week of October. The increase in the number of students attending the engineering classes has necessitated the addition to the college of a new wing, which is now being constructed. It will be entirely devoted to engineering purposes, and will contain spacious drawing rooms and class rooms, together with a large laboratory and workshop. A powerful experimental steam engine and boiler, together with dynamos for the electric lighting of the college, and new machinery are to be added to the present plant.

Telegraph Rates with Australia.—A Reuter telegram from Melbourne on 16th inst. states that at a conference of colonial Postmasters-General, held there on Monday, it was decided that the ordinary cable rate to London should be increased by 9d. a word from October 1st next, the press rate, however, remaining unchanged. The New Zealand Government has now decided to join the other colonies in guaranteeing to the companies any loss arising from the low rates, and the tariff between New Zealand and London will consequently be reduced to 5s. 3d. a word.

Electric Lighting and London Clubs.—The following letter has been sent to the *Financial Times* by Edmund Bax, manager of the Westminster Electric Supply Corporation:—"With reference to a paragraph which lately appeared in the columns of many of the London daily papers to the effect that the secretaries of the principal London clubs had resolved to request the directors of the electric light companies to reduce their price, will you allow me to state that, with but few exceptions, the clubs indicated are supplied either by the St. James's or the Westminster company? The directors of both these, while fully appreciating the importance of reducing the price as soon as possible, have felt themselves unable, at the present stage, to make any further reduction. So far, only one club—the St. Stephen's—has availed itself of a cheaper source of supply than that charged by the two companies above named, and this has already resulted in the total extinction of some 10 minutes' duration. Failures in the past have done much to check the progress of electric light, and to bring it into disrepute. The endeavour to meet the demand for cheapness has frequently been the cause, but consumers are now beginning to prefer reliability to cheapness, and find that the former is readily obtainable if a fair price is paid."

The Electro-Harmonic Society.—The first meeting of this society will take place on Friday, September 30th. Members desirous of introducing new ones should take an early opportunity of communicating with the hon. secretary, Mr. H. Alabaster, Brockenhurst, Therapia Road, Honor Oak, S.E.

Obituary.—We much regret to hear of the death, which took place at Calcutta on July 25th, of Mr. J. A. Betts, agent in that city for the India-Rubber, Gutta-Percha and Telegraph Works Company, of Silvertown. The deceased gentleman passed many years of his life in China, and was for some time in the service of the Chinese Government, whom he materially assisted in their operations against the French in the Franco-Tonquin war, particularly in the conduct of their torpedo operations. The Tonquin war over, he returned to England on a holiday, and soon after went to Calcutta in the autumn of 1888, where, in conjunction with his son, Mr. Lester Betts, he established a branch of the Silvertown firm in the East. Mr. Betts's abilities as an electrical engineer were unquestionable. He was in his 46th year at the time of his death.

NEW COMPANIES REGISTERED.

Hove Electric Lighting Company, Limited.—Capital £40,000, in £5 shares. Objects: To enter into and carry into effect the agreements with the Hove Commissioners and Messrs. Crompton & Co., Limited, mentioned in clause 3 of the articles, and to carry on within the district of the Hove Commissioners and elsewhere the business of an electric lighting company in all its branches. Signatories (with one share each): H. A. Hoare, Lloyds, E.C.; Col. A. J. Filgate, 106, Jermyn Street, S.W.; Col. H. Wood, 95, Thorpe Street, Norwich; C. F. Tufnell, Lloyds, E.C.; J. F. Albright, Mansion House Buildings, E.C.; R. E. B. Crompton, Mansion House Buildings, E.C.; F. R. Reeves, Little Heath, Potter's Bar. The number of directors is not to be less than three, nor more than five, the first to be appointed by the signatories. Qualification, £500. Remuneration, £150 per annum for the chairman, £200 per annum to be divided between the ordinary directors, and 5 per cent. of the surplus profits after the payment of 7 per cent. dividend. Registered on the 4th inst. by Deacon, Gibson and Medcalf, 4, St. Mary Axe, E.C. Registered office, Mansion House Buildings, London, E.C.

United Electric Sewage and Chemical Syndicate, Limited.—Capital £5,000 in £1 shares. Objects: To acquire, work, develop, exercise and carry out the British, foreign and colonial patents of W. Walker for (No. 14,039, of 1892) an improved process and apparatus for the purification of sewage and the production of alkalies, chlorine, ferric chloride and electric energy, and all improvements thereunder, and to carry on the business of sewage engineers, chemical engineers, electricians, electrical engineers, suppliers of electricity and manufacturers of electrical plant and apparatus. Signatories (with one share each): W. Walker, electrical engineer, 132, Adelaide Road, N.W.; W. J. Shepherd, 23, Lincoln's Inn Fields, W.C.; C. F. Wilson, Gordon Lodge, Tonbridge; W. R. Percival, 26, Canonbury Park Road, N.; T. B. Leaver, 3 and 4, Lincoln's Inn Fields, W.C.; J. T. Shrives, 337, High Holborn; H. E. Jones, 108, Coborn Road, Bow, E. Registered, without articles of association, on the 5th inst., by E. M. Walker, 132, Adelaide Road, London, N.W.

Oncken Patent Staveless Barrel Company, Limited.—Capital £150,000, divided into 50,000 ordinary and 25,000 deferred shares. Objects: To enter into and carry into effect an agreement to be made between Woodhouse and Rawson United, Limited, of the one part, G. A. Oncken of the second part, the Merxem Works, Limited, of the third part, and this company of the fourth part, and to carry on business as manufacturers of and dealers in staveless barrels, boxes, panels, veneers, and other articles and substances

made from or connected with the manufacture of wood, and machinery for the same, and also the business of electrically and chemically treating wood and other substances. Signatories (with one share each): F. W. Kellaway, 78, Upper Grange Road, S.E.; T. T. Curtis, 3, Park Villas, Park Road, Merton; H. F. Adams, 10, Brook Road, Upper Holloway, N.; C. T. Woosman, 34, Faraday Street, Walworth, S.E.; R. J. Cox, 31, Railton Road, Herne Hill, S.E.; H. Ellis, 37, Colvestone Crescent, Dalston; A. S. Jecks, 24, Austin Friars, E.C. The number of directors is not to be less than three, nor more than nine, the first to be nominated by the signatories. Qualification, £250. Remuneration, £150 each per annum, an extra £150 for the chairman, and 10 per cent. of the surplus profits, after the payment of 12 per cent. on the ordinary and deferred shares. Registered on the 30th ult. by Budd, Johnson & Jecks, 24, Austin Friars, E.C.

Slag Reduction Company, Limited.—Capital £50,000, in £10 shares. Objects: To enter into and carry into effect an agreement with F. Nettlefold, A. G. Renshaw, and A. H. Renshaw, for the sale to the company of certain patent and other rights for the use of attrition mills and magnetic separators, together with certain plant, machinery, and premises; to enter into contracts with Steel, Peech & Tozer, Limited, and with Nettlefolds, Limited; and to carry on the business of manufacturers of crushing and separating machinery. Signatories (with one share each): S. F. Prest, 2, Suffolk Lane, E.C.; A. T. Porter, 73A, Queen Victoria Street, E.C.; C. M. Smith, 47, Evelyn Gardens, S.W.; T. Adams, 17, Wharton Road, W.; G. Newington, East Dulwich, S.E.; C. T. Price, 5, Prince Arthur Road, Hampstead; J. Stewart, 24, Cecile Park, Crouch End, N. The number of directors is not to be less than three nor more than seven, the first to be nominated at the first general meeting. Qualification, 50 shares. Remuneration to be fixed by the company in general meeting. Registered on the 29th ult. by Renshaw, Kekewich and Co., 2, Suffolk Lane, E.C.

Renton Gibbs & Company, Limited.—Capital £10,000 in £5 shares. Objects: To acquire, take over as a going concern, and carry on the business of a heating and ventilating engineer, electrical and mechanical engineer, gas and water supply engineer and steam oven builder, carried on at Liverpool and elsewhere by Robert Renton Gibbs, under the style or firm of "Renton Gibbs," and with a view thereto to enter into an agreement with the said R. Renton Gibbs. Signatories (with one share each): R. R. Gibbs, 47, The Elms, Princes Park, Liverpool; E. H. Maddock, 83, South Street, Princes Park, Liverpool; R. Pollard, 125, Park Road, Liverpool; J. Hainsworth, 1, Allerton Road, Woolton, near Liverpool; J. R. Pritchard, 47, Harrowby Street, Liverpool; W. R. Walker, 7, Hawkstone Street, Liverpool; W. W. Parrish, 8, Erith Street, Liverpool. R. R. Gibbs and E. H. Maddock are the first directors. Qualification 100 shares. R. R. Gibbs £500 per annum. F. H. Maddock, and any other directors who may be appointed, £220 each per annum. Registered on the 10th inst. by Kerr and Lanham, 3, Chichester Rents, Chancery Lane, W.C.

Collier-Marr Telephone and Electrical Manufacturing Company, Limited.—Capital, £100,000 in £10 shares. Objects: To acquire and take over as a going concern the business of the Collier Audible Telephone Syndicate, Limited, with a view thereto to enter into the agreements referred to in Clause 3 of the articles (an agreement dated March 17th, 1892, between the said syndicate of the one part, and Ernest Hampson, for the company, of the other part, as modified by an agreement made the 5th inst. between the same parties, and to manufacture, construct, erect, maintain, lay down, carry out, buy, sell, let on hire, or otherwise deal in telephones, and all apparatus and things connected with the establishment, working, and maintenance of telephonic communication, or connected with the generation, distribution, supply, accumulation, and employment of electricity. Signatories (with one share each): H. Matthews, Darley Street, Manchester; H. J. Owen, 14, St. Mary's Gate, Manchester; J. E. Pilling, 27, Leaf Street, Hulme, Manchester; G. Graham, 19A, St. Clement's Road, Chorlton-cum-Hardy, Manchester; W. Spencer, 322, Manchester Road, Hollingwood; T. Chapman, 311, Bolton Road, Pendlebury; W. Frost, Spring Bank, Irlams-o'-the Height, near Manchester. The number of directors is not to be less than five nor more than seven, the first being J. W. Maclure, M.P., S. C. Thompson, J.P.; H. S. Foster, M.P.; H. F. Herford, A. T. Collier, and A. Marr. Qualification, £200; remuneration, £1,000, divisible amongst them as they themselves determine. Registered on the 10th inst. by Nicholson, Graham and Graham, 24, Coleman Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hobart Tramway Company, Limited (by electric traction).—The statutory return of this company, made up to the 14th ult., was filed on the 26th ult. The nominal capital is £105,000 in £1 shares. 45,067 shares have been taken up, of which 20,000 have been issued as fully paid. Upon the remaining shares the full amount has been called, and with the exception of £5 5s., paid in full, amounting to £25,061 15s. 250 share warrants, each comprising five shares, are outstanding. Registered office, College Hill Chambers, Cannon Street, E.C.

Chili Telephone Company, Limited.—The annual return of this company, made up to the 22nd ult., was filed on the 30th ult. The nominal capital is £250,000 in £5 shares; 40,000 of these have been taken up, the full amount called, and all calls (£200,000) paid. Registered office, 42, Old Broad Street, E.C.

Telegraph Manufacturing Company, Limited.—The annual return of this company, made up to the 29th ult., was filed on the same day. The nominal capital is £50,000 in £10 shares; 2,800 shares have been taken up, of which 646 have been issued as fully paid, and the full amounts have been called and paid on the remaining shares. Registered office, Britannia Telegraph Works, Helsby, near Warrington.

Manchester Edison-Swan Company, Limited.—The annual return of this company, made up to the 18th ult., was filed on the 26th inst. The nominal capital is £550,000 divided into 50,000 "A" shares of £9 each and 10,000 "B" shares of £10 each. 20,000 "A" and and 10,000 "B" shares have been taken up, and £1 called on each of the "A" shares, while the full amount has been called on all the "B" shares. The full amounts have been paid, amounting to £120,000. Registered office, 14, St. Anne's Square, Manchester.

Eastbourne Electric Lighting Company, Limited.—The annual return of this company, made up to 4th ult., was filed on the 25th ult. The nominal capital is £50,000 in £10 shares. 1,017 ordinary and 40 deferred shares have been taken up, and the full amounts called and paid. Registered office, Grove Road Chambers, Eastbourne.

Electrical Power Storage Company, Limited.—The annual return of this company, made up to the 3rd inst., was filed on the 9th inst. The nominal capital is £100,500, divided into 100 founders' and 20,500 ordinary shares of £5 each. 70 founders' and 18,537 ordinary shares have been taken up, of which 15,000 ordinary shares have been issued as fully paid. Upon the remaining ordinary shares £3 per share has been called, and upon the 70 founders' shares the full amounts have been called. The calls paid amount to £9,511, and unpaid to £1,450. Registered office, 4, Great Winchester Street, E.C.

BUSINESS NOTICES, &c.

The Electric Light in the City.—Since our last report, a number of further installations of the electric light in the city are to be noted, there being yet no noticeable diminution in the number of new installations being carried out. Among the new work in progress we notice that Messrs. Parr & Gilles are fitting up 93, Fore Street, E.C.—Messrs. Barnes & Low are fitting up 102, Fore Street, E.C.—Messrs. Grant & Cocks are fitting up the premises of Messrs. Norton & Sons, tailors, 155, Leadenhall Street, E.C.—At 15, Bishopsgate Street, E.C., Messrs. Laing, Wharton & Down, of New Bond Street, are busy putting up fittings. Messrs. B. Verity & Son are fitting up the premises of the Australian Mortgage, Land and Finance Company, Limited, 13, Leadenhall

Street, E.C.—Messrs. Laing, Wharton & Down are fitting up the premises of Messrs. Trinder, Anderson & Co., of St. Mary Axe, E.C., for the electric light.—Consequent on the introduction of street electric lighting in Aldgate, E.C., several installations in private premises have resulted. Messrs. John Pound & Co. are at work in the premises of Messrs. Schooling & Company, Limited, and the Essex Hotel, both in Aldgate.—Messrs. Laing, Wharton & Down are fitting up No. 4, Eastcheap, E.C., while Messrs. Moody Brothers, of Victoria Street, Westminster, are fitting up the premises of Messrs. Sheppard & Black, 2, Leadenhall Street, E.C., and Messrs. Brown, Janson & Co., 32, Abchurch Lane, E.C., for the electric light.

Thames Electric and Steam Launch Company.—Mr. Andrew Pears, of soap fame, has another venture on hand. He has taken over the Electric and Steam Launch Building Works and public charging station, now in course of construction upon Eel Pie Island, Twickenham, formerly the property of Mr. W. S. Sargeant, of Stroud-on-the-Green, Chiswick and Twickenham, and the firm in future will be known as the Thames Electric and Steam Launch Company. Mr. W. S. Sargeant will remain as manager at the works, and will certainly bring to the company a large fund of practical experience and capacity, while the name of Mr. Andrew Pears is a guarantee for the amplest financial backing. The application of electricity to river traffic has a great future before it, as its progress during the past four years will prove, and if the leading partner of A. and F. Pears throws himself into the new enterprise with but half the ardour and judgment which he has displayed in the old ones, we may not improbably witness before long some startling developments at Eel Pie Island. Apropos of Mr. Pears, it is reported, and well known, that, not content with this his latest undertaking, combined with the able assistance and long experience of Mr. W. S. Sargeant, he is still sighing for new worlds to conquer, and he may be expected to come out in yet another and, for him, quite a novel line before long.

New Lists.—Messrs. W. T. Glover & Co., of Westminster, have just brought out an exceedingly well-prepared and well-printed list in two colours, of their manufacture of copper wires. A table is given, showing the relative dimensions, weights, lengths, and resistances of pure copper wires; under the heading "weight and length," we notice that in addition to specifying the weight in pounds per yard and per mile, they also enumerate in decimals the number of yards and miles per pound respectively. This same system is observed in respect of the several other headings, *i.e.*, under "length and resistance" are given yards and miles per ohm, and ohms per yard and mile; under "resistance and weight" ohms per pound, and pounds per ohm appear. This table couples well with the catalogue of electric light wires recently prepared and issued by the same firm, which we notified in our issue of July 1st. We have much pleasure in recommending it to all in the electrical trades.

An illustrated price list of electro-medical apparatus has been issued by Mr. K. Schall, of Wigmore Street, W. As a precursor to the price list, an explanation of the physical laws of importance in using electricity for medical and surgical purposes is given, describing the necessary apparatus and their construction, and also giving practical hints about the apparatus best suited under special circumstances. The fourth edition of the book is now published, and we are not at all surprised that it has a large circulation, as in it there is information which must be very useful to all interested in electro-therapeutics. The catalogue part of the book contains very complete particulars, and a large number of illustrations, as well as minute details regarding prices of induction coils, bichromatic cells, Stoehrer's, Reiniger's, Schall's and Leclanché batteries, and numerous other electrical apparatus. We feel fully justified in recommending Mr. Schall's apparatus.

Lundberg's Switches.—We understand that Mr. Lundberg's latest patent switch, the "Unique," is rapidly gaining favour with electrical engineers, both in this country and abroad. Licenses to manufacture on royalty have already been granted to firms in Great Britain and France, and on completion of the patent in Germany and Sweden, firms in those countries have expressed their willingness to manufacture on the same terms, and parties in the United States, Canada, Austria, Belgium, and Switzerland, are being negotiated with with a similar object. We have received from Mr. Lundberg a sample of his latest pattern 3 ampère "Unique" two-way switch, which might be called the "Multum in Parvo," inasmuch as it may be wired with or without cut-out, or as a two-way or corridor switch (with or without fuse, as described). The design of this is excellent.

Country House Lighting.—Mr. H. E. Woods having decided to electric light Newbold Revel, his seat near Rugby, the installation is being arranged by Mr. A. A. C. Swinton. Some 500 incandescent lamps will be required for the house, stables, swimming bath, gymnasium, and racket court, and it is also proposed to have a search light on the top of the house. The plant still consists of two Cornish boilers, two "Parsons" steam turbines and dynamos, and accumulators, the arrangement being similar to that recently completed by Mr. Swinton at Lambton Castle for Lord Durham, and to that at present in course of construction under Mr. Swinton's direction at "Chesters" for Mr. Clayton, M.P.

Factory Electric Lighting.—Messrs. Lowdon Brothers, electricians, Tay Street, Dundee, have secured a contract for installing the electric light at the works of Messrs. A. & J. Macnaughton, manufacturers, Pitlochry. The illuminant will be introduced to the mill and factory, as well as to the private residences of the Messrs. Macnaughton, which are in close proximity to their works. Power is supplied by the turbine which drives the machinery. The installation will consist of 150 lamps, ranging from 16 to 50 candle-power each.

J. Slater Lewis.—The *Chester Chronicle* contains a lengthy letter from Mr. J. Slater Lewis, severely criticising the newspaper reports of his examination. According to what he says in his letter, he is "Pictured as a roaming, rambling, company-promoting adventurer, and those who do not know the circumstances will not have the least sympathy with me in my difficulties, which, Heaven knows, have been almost more than I could bear." He then proceeds to give an exhaustive account of his actions from the time he left the Helsby Works in 1889, all redounding to his credit, and he complains that the newspaper reports have ignored his assertions.

J. Defries & Sons.—This firm have the following installations in hand, in addition to others to which we have already referred:—Messrs. Josolym Miles & Blow, 28, King Street; Mr. W. B. Styer, 2, Threadneedle Street; the "Hercules" Tavern, Leadenhall Street; Messrs. Becker & Ulrich, 9, Fenchurch Street; Mr. Faulkes Lynch, 9, Fenchurch Street.

The Electric Light at Hammersmith.—Since our last visit to this district, we notice that several installations of electric lighting have been made, among which we may mention the premises of Messrs. Lipton, provision merchants, Mr. John House, cutler and instrument maker, and Messrs. Chibnill, confectioners. All of the establishments are in Broadway.

Ladders for Electric Work.—We hear that Messrs. J. H. Heathman & Co., of Endell Street, W.C., have recently completed a special kind of ladder for Messrs. J. E. H. Gordon & Co., of Pall Mall, W., to be used in connection with the electric light installation at Bray, Ireland.

S. P. Wood.—Mr. S. P. Wood of Hull, has taken the district agency for Tate's Electric Valve Closing apparatus, a most useful thing for preventing accidents in connection with the use of steam-power.

Removal.—Maclean's Telegraphic News Exchange have removed from St. Stephen's Chambers, Telegraph Street, E.C., to 82, Cockspur Street, Charing Cross.

Tenders Wanted—Oldham.—Tenders are being invited for making and fixing concrete culverts and the laying of electric conductors, for the Oldham Corporation. Specifications and drawings can be obtained on application to Prof. Alex. B. W. Kennedy, 19, Little Queen Street, Westminster, or to the Town Clerk, Town Hall, Oldham. Tenders must be delivered to Mr. A. Nicholson, Town Clerk, by September 2nd. A fee of one guinea will be charged for the specifications and drawings, which will be returned on receipt of a *bona fide* tender.

Tenders Wanted—Switzerland.—The civil authorities of Aarau, in Switzerland, being in possession of water-power equal ot 40 H.P., and being desirous of utilising same for electric lighting purposes, are inviting tenders until September 15th next, for the erection of a central station.

Tenders Wanted—Germany.—Tenders are being invited until September 5th by the General Direction of the Great Baden State Railways at Carlsruhe, for carrying out electric lighting on board the steamers *Kaiser Wilhelm* and *Greif*, employed in the Lake Constance traffic.

Tenders Wanted—Spain.—The municipal authorities of Villeria, Spain, are inviting tenders until September 6th for the concession—for a period of 50 years—for the electric lighting of the town, and for the erection of a central station.

Tenders Wanted—Denmark.—The authorities of the Danish State Railways at Copenhagen are inviting tenders for the supply of about 26 tons of telegraph wire, and 2,200 telegraphic insulators.

Tender Accepted—Glasgow.—In our Business Notices last week, we stated that the tender of the Brush Electrical Engineering Company had been accepted by the Corporation of Glasgow, for the dynamos for the public lighting. In connection with this, we are now informed that these dynamos will be driven, through rope gearing, by vertical high-speed engines similar to the one exhibited by Messrs. Easton & Anderson, Limited, at the recent Electrical Exhibition at the Crystal Palace, for which their tender has been accepted. Messrs. Easton and Anderson's offer for the engines was £1,108, and the offers of the Brush Electrical Engineering Company were as follows: for the dynamos, £1,510, and for the arc lamps, £7 13s. 8d. per lamp.

Tenders Accepted—Bristol.—At last week's meeting of the Bristol Town Council, the Electrical Committee reported that they had advertised for tenders for the construction and erection of condensers, pumps, steam and other pipes, at the Bristol central electric lighting station, and they recommended the council to accept the tender of Messrs. Woodhouse & Rawson United, Limited, at the sum of £3,702 (being the lowest received), and to enter into contracts with them accordingly. This was agreed to.

Tenders Accepted.—London.—We hear that Messrs. Peirson & Co.'s tender for the supply and erection of the constructional ironwork for the Meredith's Wharf Depôt of the City of London Electric Lighting Company, Limited, at £2,896, has been accepted.

Tender Accepted—Hull.—For wiring the Hull Town Hall for the electric lighting, the tender of Messrs. Roper's Electrical Engineering Company of Bradford has been accepted.

CITY NOTES.

The Cuba Submarine Telegraph Company.

THE forty-second ordinary general meeting of this company was held on Wednesday at the company's offices, 58, Old Broad Street, Mr. Thomas Greenwood presiding.

The report stated that the gross receipts for the half-year ended June 30th last, including the balance brought from last account, amounted to £24,537, and the gross expenditure to £7,311, leaving a sum of £17,226 to the credit of the revenue account. There had been throughout the half-year no interruptions of any of the cables, and therefore no repairs had been required, so that the sum of £7,000 had become available, for that had been transferred to the reserve fund. The dividend on the preference shares would absorb £3,000, and leave £7,226, out of which sum the directors recommended the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £826, being carried forward to the current half-year's account. The company's suit against the Spanish Government at Madrid was progressing.

The CHAIRMAN, in moving the adoption of the report and accounts, said the latter were as favourable as many preceding half-years. The income was rather larger than in the corresponding period of the previous year by about £1,100, but that had not arisen from any very large increase in the run of general traffic receipts, but it appeared the greater because during a part of the half-year with which they were now comparing the accounts the lines were interrupted for a little time. The expenditure was a little less than in the corresponding period, which was rather an unusual thing, because, with companies that were growing, they generally found that the outlay grew in proportion to their development. They had made a rather unusual charge for depreciation on stores and cable in stock, the amount being £984, but the directors had thought it best to err on the right side, and to keep their assets at a fully realisable value. There being no repairs to do, the directors had been able to increase the reserve fund, to meet the requirements in any future periods. The half-yearly payment of £1,875 on account of the Cienfuegos Santiago 1881 cable has now nearly ended, but they should have to make a similar charge in the half-year now current, and it might be desirable to end the whole charge during that period by paying another £400 or £500. Then the charge would cease to be paid by the company, and the whole of the cables would belong to them, they being at the cost of repairing them instead of the contractors.

Mr. C. W. PARISH seconded the motion.

In reply to a question by Mr. LYDDON,

The CHAIRMAN said he could give no further information about the company's suit against the Spanish Government than was contained in the report. These things dragged their weary length along. He thought they should be able to satisfy any court of justice that the laying of a cable parallel with their own was a direct violation of their concession. He did not think the Government would press the matter, and the company were not suffering in regard to it.

The report and accounts were unanimously adopted, as was also a resolution authorising the payment of the dividend.

The retiring director, Mr. C. W. Parish, was unanimously elected, and the meeting closed with a vote of thanks to the chairman and board of directors.

Pioneer Telephone Company, Limited.

AN extraordinary general meeting of this company was held on Tuesday last at Winchester House, the Duke of Marlborough presiding.

The SECRETARY (Mr. J. Cecil Bull) read the notice convening the meeting, and

The CHAIRMAN said: There was not a large attendance of shareholders, because the statement which they had to make was an eminently satisfactory one. The Pioneer Company was formed for the purpose of initiating a new departure in this most important industry, and was extremely well responded to, and he was glad to think that those persons who invested their money in that enterprise were able to secure what he was sure they would feel a very reasonable profit on the risks which they had to incur. It was said at the time by certain organs of the press that the Pioneer Company was simply a *ballon d'essai* for the purpose of finding out what the possibility was of establishing a rival competition to the existing company. The real object, however, of the Pioneer Company was to benefit the shareholders, and also to really benefit the telephone system of the metropolis. He had no reason for going back upon that intention, because he thought that the prospects were likely to be fully realised. The Pioneer Company, during its course of existence, did a lot of very useful work; it made a series of contracts of a very important character, all with a view towards the eventual establishment of a very complete London system. It entered further into contracts with an existing company at Manchester, which it acquired. It therefore was the possessor of a going concern, and even if the Pioneer Company had delayed the issue of the larger company, it would still have been a going investment for the shareholders, for they were possessed of an absolutely going undertaking, which was paying a fair rate of interest upon its expenditure; he alluded to the Mutual Telephone business at Manchester, which was purchased by the New Telephone Company. Perhaps it would be hardly opportune for him to enter upon a discussion of the objects of the company which had been formed by the Pioneer Telephone Company, and he would confine himself to reiterating the fact that the object for which the Pioneer Company was formed had been accomplished. The New Telephone Company had now a real existence, and he might say, speaking very positively, that there was no doubt that the New Telephone Company would be the means of producing a great improvement in the service of the Metropolis in conjunction with—not in conjunction—but in affiliation with the efforts of the National Telephone Company to expand that most valuable invention. The advantage to the New Telephone Company shareholders was considerable, in the fact that an *alliance* of a working character between the National and the New Telephone Company had been arrived at, as there would be no waste of capital in establishing rival systems, while at the same time the demand for the new invention was so large, and the field so vast, that there was plenty of scope for the capital of both enterprises. From the point of view of the public an advantage was also occurring; that was that instead of there being two rival groups of subscribers in different towns, or in the metropolis, subscribers to the one system would be able to talk through to subscribers of the other system, and brokers and men of business in the city would not be obliged to have two telephones belonging to the two companies in order to be able to speak to all persons who possessed a telephone. He thought he had sufficiently justified the resolution by stating what had been achieved. He then moved that "the Company be wound up voluntarily."

Mr. HENRY PEMBERTON LEACH seconded the resolution.

Some questions were put to the chairman by Mr. EMMOTT (a shareholder). He did not consider 20 per cent. a very grand profit for the shareholders, considering the risks they had to undergo. He did not look upon the Mutual Telephone Company, at Manchester, as being worth £60,000.

The CHAIRMAN having replied, the motion was put to the meeting and carried.

Mr. A. A. CAMPBELL SWINTON proposed, and Mr. MACKWORTH PRAED seconded, "That the directors be paid £1,000 by way of remuneration for their services in connection with the company, divisible in such manner as they might determine."

This was unanimously carried.

The CHAIRMAN stated that they were sorry they were not in a position to offer the shareholders shares in the New Telephone Company in exchange for their shares in the Pioneer, for certainly he himself would have no hesitation in saying that they would soon rise to a very good premium. He would risk his connection with the telephone enterprise in this country in saying that. The meeting then closed.

Collier-Marr Telephone and Electrical Manufacturing Company.

THIS company has been formed with a capital of £100,000 in 10,000 £10 shares, of which 5,000 were offered for public subscription until noon yesterday (18th inst.). The objects of the company are, to manufacture upon improved principles various telephone instruments, and with this object to acquire from the Collier Audible Telephone Syndicate, Limited, the patents and patent rights granted to Messrs. A. T. Collier and Alexander Marr, also the works in Derby Street, Manchester, including the plant, machinery, stock-in-trade and effects of the said syndicate. The prospectus states that the inventor of the "Collier" receiver, by using both ends of the electro-magnet, claims to have obtained the fullest power obtainable, thus making any further development of the receiving instrument impossible. The prospectus chiefly deals with the validity and merits of the patents. A few orders, it seems, have been received and contracts entered into. For our comments on this prospectus, see page 230.

Liverpool Overhead Railway Company.

THE half-yearly meeting of the Liverpool Overhead Railway Company was held last Tuesday in Liverpool, Sir William B. Forwood in the chair. Questions were asked about the recent issue of debentures, several shareholders complaining that they had not had the opportunity of subscribing for them. The chairman explained that ample notice was given that the debentures were to be issued. No application was received from a single shareholder, and the directors felt that if they had offered the bonds to them they might have been left with some for which they could find no customers. The bonds were taken by the Bank of Liverpool, and the company had paid the bank 1½ per cent. to cover brokerage and all costs of issue. The report was adopted.

Westminster Electric Supply Corporation, Limited.

—The board, on 10th inst., declared an interim dividend for the half-year ending June 30th last, at the rate of £3 per cent. per annum. This dividend will be payable on September 15th next to all shareholders whose names were on the register on August 10th, and the warrants will be issued in due course.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 12th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, amounted to £2,818.

The West India and Panama Telegraph Company. The receipts for the two weeks ended August 15th, show an increase of £252 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, August 4th.	Closing Quotation August 18th.	Business done during week ending August 18th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —103	100 —104	103	101½
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47½— 48¼xd	47 — 48	47¼	47
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88¼xd	87½— 88½	88	87⅝
2,849,510*l*	Do. do. Deferred	Stock	11 — 11½	10½— 11	10⅝	10½
130,000	Brazilian Submarine Telegraph, Limited	10	10¼— 10⅝	10¾— 11¼	11	10⅝
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102 xd	100 —103	101½	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	104⅜	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞— 3⅛	2⅞— 3⅛	3	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2 5/16	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½xd	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	9¾— 10¼	9¾— 10¼	10⅛	10
$7,716,000	Commercial Cable, Capital Stock	$100	160 —165	160 —165	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛— ⅜	⅛— ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6xd	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11⅜	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17½— 18½	18	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11⅝	11⅜— 11⅝xd	11 9/16	11⅜
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝— 14¾xd	14⅜— 15	14 9/16	14⅜
70,000	Do. 6 p. c. Preference	10	15¼— 15⅜xd	15½— 16	15⅝	15½
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109 xd	106 —109	108½	107½
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	109 —112	111½	110⅜
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15⅛	15 1/16
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	103 —106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110 xd	108 —111	110	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104 xd	101 —104	102¼	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4⅜— 5¼	4⅜— 5¼	5⅛	5
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1 — 1¼	1⅛— 1⅛	1	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛— 2⅜	2⅛— 2⅜	2⅜	2 5/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛— 1⅜	1⅛— 1⅜	1¼	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10¼xd	10⅛— 10⅜	10⅛	10⅛
180,042	Do. do. 6 p. c. Preference	10	15 — 15½xd	15½— 15⅝	15⅜	...
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	107 —110	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	6 — 7	6 — 7	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20½— 21½	21½— 22½	21⅝	21½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6¾— 7¼	6¾— 7¼	6⅞	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4⅜	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13½— 14 xd	13⅜— 14½	14 3/16	14
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13 — 13½xd	13 — 13½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 —111	109 —111	110½	109⅝
250,000*l*	Do. (issued at 5 p.m., all paid)	...	109 —111	109 —111	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛— ¼	3/16— 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	7⅞	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½— 7⅝ xd	7½— 8	7⅝	7 11/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅝— 8¼ xd	7⅝— 8¼	8 1/16	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	118½	116¼
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	3⅜	3 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	43 — 45	44½	43¼
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6 — 8 xd	6½— 7½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —104	103½	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	3 7/16	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8¾— 9¼	8¾— 9¼	9	8¾
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅝	...
30,364	Do. do. do. 5 p. c. Deferred	7½	2¾— 3¼	2½— 3	3	2⅝
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 - -105 xd	102 —105	103	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105 xd	102 —105	104½	103¼
88,321	West India and Panama Telegraph, Limited	10	1⅛— 1⅜	1 — 1¼	1 3/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼— 9⅜	9¼— 9⅜	9⅜	9¼
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	8 15/16	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106	101 —105	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	120 —125	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼	5⅜— 6¼xd	6⅛	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20⅛.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2⅛—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), —£5 Preference (fully paid), 2¼—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892)

THE CURRENT THAT CURES.

BY H. NEWMAN LAWRENCE, M.I.E.E.

(*Continued from page* 209)

OTHER evidence of what the current cures is to be found in several of our large general hospitals, wherein distinct electrical departments have been established. Three such departments I know of in London, viz., at St. Bartholomew's, St. Mary's, and Guy's. There may be others. Some of the special hospitals, notably those devoted to cases of paralysis, also make the use of electricity an important feature.

From these hospitals I had hoped to obtain statistics of the work done in their electrical departments; but, in response to my application I find that, for the most part, official reports on these departments either do not exist, or are not available. My applications have been treated in a circumlocution-office manner, and when at last the medical man in charge of the department has been reached, I have found, for the most part, that this high priest of hospital electro-mysteries cannot vouchsafe any information. This is matter for regret, especially as the object for which the information was required was clearly stated. Still, the mere fact that such departments do exist is strong evidence that some of the authorities of our important hospitals recognise as a fact that electricity does take high rank as a curative agent.

In the absence of official statistics, much cannot here be said of the extent to which the general hospitals give evidence in the required direction, but I may mention, by way of practical illustration, an incident which occurred in the electrical department at St. Bartholomew's, on one occasion when I visited it by the invitation of the late esteemed physician-in-charge, Dr. W. E. Steavenson. A poor man was under treatment for stricture of the urethra, and when I spoke to him told me with tears of gratitude in his eyes that he had been in terrible pain and misery for months while the doctors in his own neighbourhood (somewhere on the south coast, I think) told him they could do nothing for him. One, however, had advised him to come to London and see Dr. Steavenson, with the result that three or four applications of electricity by that master-hand had enabled him to resume his national functions with ease and comfort, so that he was about to return to the country with a new lease of life.

By the courtesy of the secretary and the electrician in charge, I am able to give some statistics concerning the use of electricity at the National Hospital, Queen Square. A room is set apart for electrical treatment, and is called the electrical room. To this come out-patients three times per week, and last year 4,059 attendances were made. Besides this, about a third of the in-patients (839) are also under some form of electrical treatment. This particular hospital is devoted to the special diseases of paralysis and epilepsy, but the electrical treatment is used in cases of the former only. The medical authorities here do not use it in epilepsy, though Althaus in our own country, Erb in Germany, and others in America speak favourably of it in this connection. Many forms of paralysis are treated electrically here, but such treatment is not alone relied upon. I was given to understand that electricity was regarded as an adjunct rather than a principal agent in the curative work. Be that as it may, the further information that the proportion of patients for whom electrical treatment is prescribed is steadily on the increase, goes to show that the curative effect of electricity in cases of paralysis is being more and more appreciated, even where, as in the present instance, the the methods of dosage employed were distinctly of a primitive order.

My own experience affords strong additional evidence. I have carried out or assisted in successful treatment in many cases, and have also had some failures, but several years' experience has greatly strengthened the belief in which I started, viz., that if electricity be carefully and scientifically applied it is the best and safest remedy for a very large number of the ills which flesh is heir to. A few cases will serve to indicate my grounds for this conviction. A young lady suffering from a severe attack of rheumatism, which had confined her to her bed for weeks, was able after five applications of electricity to go and dance at a ball and then visit some friends in the country. When heard of, two years' later, she had not had any return of rheumatism. An officer in the army was very deaf and could scarcely hear the ticking of a watch close to his ear. After short treatment, he was able to hear the watch 10 inches away. A clerk suffering from writer's cramp and had lost his situation in consequence, was able in a few weeks to write a letter of thanks for the benefit he had received from electrical treatment. A girl with a face frightfully disfigured by paralysis, and who had been told by several doctors that she would never recover, in two months was perfectly cured and showed not the slightest trace of the previous disfigurement. A gentleman suffering from locomotor ataxy, and scarcely able to walk at all, was rendered able to walk up and down stairs with safety and comparative ease. A Government official, troubled with long-standing insomnia, and who had tried innumerable remedies without success, was put to sleep in the operating chair. A servant girl who, owing to St. Vitus dance, had been obliged to give up her occupation, was in six weeks sufficiently restored to health to enable her to resume work.

These are a few cases which occur to my mind as I write, and many more might be added, but I think they will be sufficient to justify the above statement; and, on the principle that "seeing is believing," warrant me in adding my own evidence to that of the eminent authorities I have quoted. So far I have referred almost entirely to the healing or palliative effect of the current upon disease, but its destructive property is also largely used in surgery, and cures effected thereby indirectly. The electrolytic and heating properties of current are taken advantage of by many modern surgeons for the smaller operations. The late Dr. W. E. Steavenson's work on electrolysis in surgery shows how he had employed electricity, for the most part successfully, for the destruction of numerous abnormal or unsightly growths both upon and within the body. Dr. Inglis Parsons has published records of many cases of cancer which have been wholly or partially cured by electric currents applied in a special manner which he has devised. Dr. Thos. Keith, a great authority in gynæcology, declares that in many cases he much prefers electricity to the use of the knife, while the electro, or as it is generally called, the galvano-cautery, is largely used for the destruction of minor unnatural growths in preference to any other means.

It is manifest that what I have here said is but a very brief *resumé* of facts which might be expanded almost *ad infinitum*, but it brings us to the definite conclusion that there is a "current that cures." Moreover, in spite of almost unheard of opposition, suspicion, and indifference, in quarters from which one would have expected rather encouragement, medical electricity has won for itself an honourable position in the treatment of a large proportion of the diseases of man. It answers the question, "What does the current cure?" in a clear and unmistakable manner, which is worthy the serious attention of all concerned—of medical men as the trustees of the healing art, of electricians as those specially interested in applied electricity, and of the public generally, as anxious searchers after all that tends to alleviate the ills of mankind.

(*To be continued.*)

LEGAL.

Lane-Fox v. The Kensington and Knightsbridge Electric Lighting Company.

JUDGMENT.

IN giving judgment in this case in Court of Appeal II., on Wednesday, the 10th inst.,

LORD JUSTICE LINDLEY said: This is an appeal by the plaintiff against a judgment of Lord Justice A. L. Smith, dismissing an action brought for the infringement by the defendants of a patent belonging to the plaintiff. As usual in such cases, the defendants denied the infringement, and denied the validity of the plaintiff's patent on the ordinary grounds of want of subject-matter, want of novelty, want of utility, insufficiency of the specification; and, in addition to these, the defendants contended that the nature of the invention, as described in the provisional specification, was not the same as that described in the complete specification; at any rate, after it had been

amended and put into its present form. Lord Justice Smith decided in the defendants' favour on the last point, but he also came to the conclusion that the invention as described could not be usefully worked; and that the directions to work it were insufficient. He, however, decided the other points in favour of the plaintiff, and believed that if the patent had been valid, the defendants would have infringed it. A cross notice of appeal was given by the defendants, and the whole case was argued at great length before this Court by Mr. Lane-Fox in person, on the one side, and by Mr. Wallace, as counsel for the defendants, on the other. The Court was supplied with a printed copy of the shorthand notes of the evidence in the Court below, and of the arguments of counsel on the trial of the action, and of the judgment of the learned judge. All these I have carefully read and studied since the argument in this case was closed. The plaintiff's patent, as described in his original specification, was for "improvements in obtaining light by electricity, and in conveying, distributing, measuring and regulating the electric current for the same, and in the means or appliances employed therein." The provisional specification was filed on October 9th, 1878, and the complete specification was filed on April 9th, 1879. Owing to subsequent disclaimers and amendments, which it will be necessary to examine more carefully by-and-bye, the only part of the patent which has to be considered is that relating to the distribution and regulation of electric currents for purposes of lighting. In order to understand the nature of the plaintiff's invention, and the objections taken to the validity of the patent, it is necessary to ascertain what was the state of knowledge as regards electric lighting in 1878. This is by no means an easy matter, for since that time much has been learned, vast improvements have been made, and the progress has been so fast, and yet so gradual and continuous, that there is great danger in supposing that what is plain and well known, was plain and well known then. The evidence given in the case shows that the following matters were well known in 1878:—(1) that electricity could be used for lighting purposes; (2) the arc or brush light was known, and in course of being perfected; (3) that incandescent lighting was foreseen as possible and probable, and that many persons were trying to discover how to effect it; (4) that electric generators, and what are now called dynamos, were well known; (5) that Planté's secondary batteries, capable of being charged by an electric current, and of storing electricity (*i.e.*, of remaining inert), and of giving electricity out when wanted, were well known, and had been used for lighting; (6) that the voltage of the electric current given off by such batteries could be increased or diminished by adding or removing cells; (7) that in order to obtain and maintain an electric current, a complete conducting circuit was necessary; (8) that for currents of low tension, the earth itself might be used for a return conductor; (9) that earth, or "an earth," was a technical expression used to denote any suitable return conductor; and (10) that any competent electrician would know that in any particular case he could not use the earth itself as a return conductor, and that some other return conductor would have to be provided. On the other hand, the evidence shows that in 1878 it was not known how to construct an incandescent electric lamp for any generally useful purpose. It was not known to be important for the purpose of lighting with such lamps that the current supplying them should be kept at a constant pressure of about 100 volts, nor was it known that good results for incandescent electric lighting would be obtained by using secondary batteries, such as Planté's, in conjunction with dynamos. Further, in 1878 dynamos did not work so smoothly as they do now, and some better method of regulating the action of the engines used to drive them was necessary, or at least, desirable. Lastly, it was not known that for lighting large districts with incandescent lamps with electrical currents of high tension, the earth could not be used as a return conductor. Such being the state of knowledge in 1878, the plaintiff claims by his patent to have done three things which were new and useful, viz.—(1) he claims to have invented a lamp which would answer the purpose; (2) he claims to have invented a method of keeping the electromotive force of the current in the mains constant at about 100 volts; (3) he claims to have invented a method of better regulating the engines which drove the dynamos. The lamp has been since replaced by cheaper and better ones, and has been disclaimed. The regulator has become unnecessary by reason of improvements in engines and dynamos, and has been disclaimed; but it was a very important part of the original invention. There remains the invention for keeping the electromotive force of the current constant. This invention is the one which has to be considered in this action. An invention is not the same as a discovery. When Volta discovered the effect of an electric current from his battery on a frog's legs, he made a great discovery, but no patentable invention. Again, a man who discovers that a known machine can produce effects which no one knew could be produced by it before, may make a great and useful discovery; but if he does no more, his discovery is not a patentable invention. [Britain *v.* Hirsh, 5 Patent Cases, 232; Harwood *v.* Great Northern Railway Company, House of Lords, 654; Horton *v.* Malvern, 12 C. B. N. S., 437; Saxby *v.* Gloucester Waggon Company, 7 Q. B., 305.] He has added nothing but knowledge to what previously existed. A patentee must do something more; he must make some addition not only to knowledge, but to previously known inventions, and must so use his knowledge and ingenuity as to produce a new or useful thing or result, or to produce a new and useful method of producing an old thing or result. On the one hand, the discovery that a known thing—such, for instance, as a Planté battery—can be used for a purpose for which it has never been used before, is not alone a patentable invention; but, on the other hand, the discovery how to use such a thing for such a purpose will be a patentable invention if there is novelty in the mode of using it as distinguished from novelty of purpose, or if any new appliance is necessary for using it for its new purpose, and if such mode of user or modification or appliance involves any appreciable merit. It is often extremely difficult to draw the line between patentable inventions and non-patentable discoveries; but I have endeavoured to state the distinction as I understand, and as far as is necessary, for the purposes of the present case. I have of course been guided by the previous decisions on the subject, and especially by Harwood *v.* Great Northern Railway Company [11 House of Lords, 656], which is the most instructive of them all. I have been induced to make the observations in order to apply them to the question whether the plaintiff's invention is anything more than a discovery that Planté's cells can be usefully employed for incandescent lighting. If it is not his invention will not be the subject matter of a patent. What, then, is the nature of his invention as described in his original specifications? It certainly is not for the mere use of Planté's batteries in connection with dynamos. It is for the use of them "as described," which is a very different matter. Read the provisional specification, page 2, line 12, to the end; and the complete specification, page 4, line 11, to the end, omitting that part which relates to measuring. I cannot read these specifications without coming to the conclusion that the plaintiff thought he had discovered how to overcome one of the greatest difficulties in incandescent lighting. He points out that the electromotive force of the electric conducting mains should be kept constant at about 100 volts by means of dynamos and secondary batteries used as described at various places, and in conjunction with the regulator, which he says is necessary. That is his discovery, and the nature of his invention, as stated by himself. It is not put in this simple form; it is mixed up with the mode of carrying the invention out. The plaintiff not merely discovered that Planté secondary batteries could be usefully employed for incandescent lighting, but he showed the importance of keeping the electromotive force in the mains constant at the best voltage, and he claims to have shown how practically the desired result could be obtained, which no one knew before. As regards the nature of the invention, as originally described, and as regards its being the proper subject matter for a patent, my decision is in favour of the patentee, provided always that his invention proves practicable. This accords with the view taken by Lord Justice Smith. But this view of the plaintiff's invention is of no use to the plaintiff, for neither the defendants nor anyone else use this invention as it was originally described. The plaintiff now claims something very different, viz., the use of secondary batteries, in conjunction with dynamos, for the purpose of keeping the electromotive force constant in the mains, at about 100 volts. Lord Justice Smith held this to be an invention very different from that originally described, and he also held that if this was the plaintiff's invention, it would not work without modifications and precautions 'which' the plaintiff never pointed out. I agree with him in both points, and I will take the last first. It is, I think, clear that no one had ever shown, or professed to show, how to produce this desired effect before 1878. Many prior patents were referred to by the counsel for the defendants to show want of novelty in the plaintiff's invention, but there is no trace in any of them of any method of keeping the electromotive force in a main constant at any particular voltage, nor was that the object of any of them. I dismiss them all with that short observation. I pass from the novelty to the utility of the alleged invention, and to the sufficiency of the specification for carrying it out. The utility of the alleged invention depends, not on whether by following the directions in the complete specification all the results now necessary for commercial success can be obtained, but on whether by such directions the effects which the patentee professed to produce could be produced, and on the practical utility of those effects. Can it be said that the invention, as described in the amended specification was, in 1878, a practically useful addition to the then stock of inventions? To judge of utility, the directions in the amended specification must be followed, and if the result is that the object sought to be attained by the patentee can be attained, and is practically useful at the time when the patent is granted, the test of utility is satisfied. Utility is often a question of degree, and always has reference to some object. Useful for what? is a question which must be always asked. The answer must be—useful for the purposes indicated by the patentee [*see* per Tindall, L.C.J., in Cornish *v.* Keane, the Web's Patent Case, Edison *v.* Holland, 6 Patent cases, 243, and Badische Anclin und Soda Fabrik *v.* Levinstein, 12 Appeal Cases, pages 712, 719, 720]. An invention may be useful as indicating the direction in which further progress is to be expected, and yet the same invention may be useless for any other purpose, useless, that is as an invention without further developments and improvements which have not occurred to the patentee. This is, in my opinion, the real truth with respect to the plaintiff's invention, as now claimed by him. He made a distinct and important step in advance. The plaintiff was the pioneer; he showed others the road to be followed, but he did not give the traveller the information necessary to enable him to travel on it. There were difficulties to be overcome which the patentee did not foresee, and against which he naturally made no provision. There is an enormous mass of conflicting evidence upon the possibility of obtaining practically useful results by following the directions contained in his specification. Much of the evidence adduced against the patentee merely goes to show that by following the directions in the specification you cannot produce such good results as are produced by the defendants. This is obviously wholly immaterial. But there is besides, a great deal of evidence to show that an electrician of ordinary skill could not have produced any useful result in 1878, if he simply followed the directions contained in the specification as amended, with such variations only as an electrician of ordinary skill would have known how to make in 1878. So much more can be done now by a Planté battery than was suspected in 1878, that I have found the greatest difficulty in coming to a conclusion on this all-important question, and I much regret that we have not had the assistance of an expert in electrical science to assist us. I have studied the whole evidence with all the care I can bestow upon it, and I have come to the conclusion that the plaintiff had not in 1878 invented what he now says he had, viz., a practicable method of keeping the electromotive force in

the mains constant at about 100 volts by means of secondary batteries and dynamos used simultaneously as described. The evidence adduced by the plaintiff shows that something like his invention can be worked on a small scale, and to a limited extent, when it is not necessary to charge the mains so as to produce a high pressure when the lamps are connected with the main. Prof. Barrett's evidence as to what he did in his own laboratory for six years shows this; and it must be borne in mind that for a time he used water pipes and the earth as a return conductor, and showed them to be sufficient. But his voltage was low; his dynamo produced a current at a tension sufficient for his lamps without the aid of secondary batteries, and he used his batteries as reservoirs rather than as regulators. Moreover, Prof. Barrett did not produce these results earlier than 6 or 7 years ago, when much more was known about what could be done with Planté batteries than was known in 1878. The other cases in which the plaintiff endeavoured to prove that his invention had practically succeeded will be found to have involved considerable important departures from his invention as described. The installation for Lady Conyers's ball is the best case the plaintiff has. But there the batteries were taken charged, which is a very important matter. The defendants have, in my opinion, succeeded in proving that the lamps will be destroyed if, whilst they are connected with the main, the batteries are charged at a sufficient voltage to work for any useful purpose. This objection to the patent goes to the root of the plaintiff's alleged invention. The objection is said by the plaintiff to be based upon the erroneous assumption that the batteries must be charged and emptied to an extreme extent. Charging and discharging no doubt are relative terms to be understood within reasonable limits; and a workman intelligent enough to seize the idea of the patentee would perhaps know in a general way that the electromotive force could be regulated and kept approximately constant without excessive charging or discharging, and the brightness or dimness of the lamps would be his guide. But conceding this, I think it proved that high charging is necessary to keep the electromotive force constant and at anything like 100 volts; and, if necessary, it is not disputed that the lamps will be destroyed if the batteries are charged when the lamps are on, unless precautions against this cause of failure are taken. None, however, are indicated in the specification. I think it proved that a small variation in pressure in the main will cause a current to go into or come out of the secondary battery for a very short time. But this is not enough for practical purposes. High charging being necessary, it is, in my opinion, proved that the plaintiff's invention will not work without switches; and these are not mentioned in the specification. Upon this point there is much conflicting evidence attributable in great part, at all events, to the ambiguity of the term switching. It was known before Planté invented his secondary batteries that the voltage of primary batteries could be increased or diminished by increasing or diminishing the number of cells. The mechanical means of doing this is called switching; and Planté himself pointed out that the voltage of his secondary batteries could be increased or diminished by similar means. Regulation to some extent takes place without switches. It is admitted by the defendants' own witnesses that the batteries have a steadying effect for a short time; that they act as regulators to some small extent, and Prof. Barrett has produced satisfactory results in his laboratory with low voltage without switches. In Lady Conyers's case there were no switches, but there was no dynamo at work. On the other hand, the evidence convinces me that for practical lighting with an electromotive force of about 100 volts and with dynamos and batteries and lamps all in use, switching is essential, and that no ordinarily competent electrician would have known in 1878 how to keep the electromotive force in mains constant at about 100 volts without further instructions than the plaintiff gave him. The plaintiff's claim to have invented in 1878 a practically useful method of keeping the electromotive force in the mains constant at about 100 volts, whilst the dynamos are running and the batteries are being charged, and the lamps are on, cannot, in my opinion, be sustained. This is the broad ground on which, I think, the patent as amended must be invalid, and this was the only ground on which Lord Justice Smith condemned it on its merits. Having arrived at this conclusion, it is unnecessary to consider the objections taken to the specification upon the ground that the directions about the earth were misleading, and that the direction that the cells of the batteries should have very large conducting plates, was too indefinite. I have hitherto made no allusion to the plaintiff's regulator; but this was, in my opinion, an essential part of his original invention. He says in his original specifications that it is necessary for what? The context shows that it was necessary to keep the electromotive force in the mains constant. This was a mistake, and the regulator, and all that was said about it, has been disclaimed and struck out by amendment. But the effect of this is entirely to change the nature of the invention as described in 1878, and to enlarge it, which is not permissible [*See* Gaulard & Gibbs, Patent Cases 215]. In the original specifications the plaintiff drew a marked distinction between storing and regulating; the secondary batteries were for storing, the regulator was for regulating. It is true that storing involves of necessity a certain amount of regulation; but over and above such regulation as is necessarily incidental to storing, further regulation was said by the inventor in 1878 to be necessary for his invention. Between 1878 and 1883 he discovered that the regulator was not wanted, and that everything could be done by secondary batteries as used in 1883, by which time dynamos and switching had been greatly improved. He accordingly disclaimed the regulator. I am satisfied the plaintiff had no idea that he could do without the regulator when he obtained his patent. He learned it afterwards: and by disclaiming the regulator and amending his specification, in 1883 as he did, the plaintiff essentially changed the nature of his invention for keeping the electromotive force in the mains constant. The claim to the use of the batteries as reservoirs had a definite meaning in the original specification, but it has a different and much wider meaning in the specification as amended in 1883. The plaintiff is now really claiming a patent for the mere use of Planté's batteries in conjunction with dynamos. Such a patent would not have been valid unless the patentee had done something more: he must have shown how the two were to be successfully worked together. Assuming that a patent for such an invention might have been obtained, the plaintiff's patent was not granted for any such invention. The effect, therefore, of the disclaimer and amendment made in 1883 has been to destroy the validity of the plaintiff's patent if it ever could have been made to work. Upon this point, again, I agree with Lord Justice Smith. It is needless to consider the question of infringement. I will only add that if plaintiff's patent could be upheld as a patent for the use of secondary batteries in combination with dynamos, then the defendants would obviously have infringed his patent. But unless his patent can be upheld to this extent, no infringement has taken place. Convinced, as I am, that the plaintiff made a great step in advance when he suggested the application of Planté's batteries for purposes of incandescent electric lighting, I feel bound to hold his patent invalid on the ground that it was granted for an invention very different from that which he now claims to be protected; and on the ground that it was not in 1878 useful for the main purpose for which it was invented, viz, the practical lighting of large districts, and upon the ground that his specification was insufficient to enable an electrician of ordinary competence and skill to carry it out without further experiments and invention as distinguished from more practice and increased dexterity and skill. The appeal, therefore, must be dismissed, with costs in the usual way.

LORD JUSTICE LOPES concurred.

LORD JUSTICE KAY: This action is brought to restrain infringement of the plaintiff's patent, and for an account of profits or damages. The patent is dated 1878, and has been amended by two disclaimers, in 1882 and 1883. The case is one of some difficulty, and the difficulty arises in great measure from the fact that the patent relates to electric lighting by incandescence, and in 1878 no practical mode of doing this had been perfected. Mr. Lane-Fox contemplated lamps in which the incandescent material was platinum or iridium, which was to be maintained at a luminous heat not *in vacuo*. The incandescent lamp now in use, in which the material is carbon enclosed in a glass bulb exhausted of air, was not brought into practical use until some years after Mr. Edison's patent in 1881. The real object of this action is to claim the exclusive right to the use of what are called accumulators in the modern system of electric lighting. I understand that accumulators are, in fact, what were originally called secondary batteries. They were invented or improved by Planté, and at the time of this patent were known as Planté's batteries. They are not batteries for the original generation of electricity, but, if I rightly understand the evidence, they are constructed of plates of lead partly immersed in dilute sulphuric acid, the alternate ones connected with the positive and negative poles of the battery, and in the circuit with a dynamo or other generator of an electric current. When electricity is by the action of such generator passed through the battery, an alteration takes place in the lead plates by the deposit upon their surfaces of peroxide of lead. When the generator ceases to act, if the circuit is continued, there is a re-solution of that peroxide, and the battery during that chemical process gives out a considerable quantity of electricity. Directly the generator ceased to act, however, the electromotive force—called otherwise the voltage or potential—lowers at first rapidly, and then much more slowly, and the current is maintained at this lower voltage for a considerable period, varying, of course, with the size of the plates in the battery and the quantity in ampères of the charge. All this was known before the plaintiff's patent, and Planté batteries are accordingly mentioned in his provisional specification as "reservoirs" of electricity. The provisional specification does not indicate distinctly that they were intended in his combination to answer any other purpose. The combination which he claims that the defendants are infringing consisted of several elements—(1) a number of incandescent lamps arranged not in series, but what is very inartistically called in parallel, that is, through each of which passes not the whole current carried by the main wire, but a portion only drawn from the main wire by a small wire serving the lamp from which it is returned also by a separate return wire; (2) the introduction into this system of several Planté batteries joined in like manner to the main wire at different points, and each having a separate junction with the return. The complete specification contains this sentence: "In order to keep the electromotive force in the mains constant, it is desirable to have, in the first place, several generating machines, also a number of reservoir batteries, as before explained. In the provisional specification, the last clause of that sentence, "also a number of reservoir batteries, as before explained," did not occur. Instead, the sentence ran thus: "Next, it is necessary to have some regulator, such as that about to be described." The regulator was an electrometer, the needle of which oscillated between two metal points. When the voltage was too high it touched one, and completed a circuit which actuated a lever so as to shut off steam, and this diminished the speed of the dynamo. When the voltage got too low, the needle deflecting in the opposite direction touched another metal point which produced the contrary effect, and quickened the motion of the dynamo. This regulator is struck out by disclaimer, and now in the altered specification the only regulation is keeping the electromotive force in the mains constant, which is to be done by (1) several generating machines and (2) a number of reservoir batteries. I find it impossible to make the provisional and complete specifications consistent in this respect. The provisional describes the mode of keeping the electromotive force constant (1) several generating machines, and (2) the electrometer regulator. It does not mention the secondary batteries as useful for that purpose, but as reservoirs only. Mr. Lane-Fox argued

before us that their purpose was to act as a sort of buffer (to use the expression he frequently employed), and, accepting an illustration suggested by the bench, he said their office was something like that of the air vessel in a force-pump which arrests the pulsation of the pump, and causes the water to be delivered in a continuous stream. I am satisfied by the evidence that this would not be the effect of the secondary batteries if employed as described by his patent. He directs them to be charged from the dynamos while some lamps are in the circuit. Taking the voltage requisite for the lamps at 100, I think it is clear that the batteries, at least with any reasonable size of lead plates, could not be charged so as to be useful for this purpose with a current of less than 115 to 125 volts, which would destroy the lamps in a short time; even if properly charged they could not practically be used to keep up the current when the dynamo was not running without an arrangement by which the number of battery cells in connection with the main wire could be altered from time to time by a system of switches. If the use of the batteries was to keep the electromotive force constant in the main wires there are are two objections to this patent, each of which seems to me formidable. First, this is not contemplated by the provisional specification, which describes a different mode of effecting that purpose, and therefore differs essentially from the complete specification, and, secondly, the mode of using the batteries described in the complete specifications of this patent will not produce the effect of keeping the electromotive force constant in the main wire. The use of these batteries as reservoirs of electricity was merely using them for the purpose for which they were invented by Planté, and a patent for putting such reservoirs in connection with the main wires in a system of electric lighting involves no invention whatever any more than using water reservoirs in connection with pipes supplying a city with water. By disclaimer the plaintiff struck out from his specification the regulation by the electrometer. As I read the provisional specification, this, and the employment of several generating machines, was the only mode of regulation which the patentee originally contemplated. But I think by regulation he did not mean keeping the electromotive force, as nearly as possible, constant in the various wires. The disclaimer has struck out one device for effecting this, which is said both in the provisional and complete specification to be "necessary," and it may be a question whether this is not an alteration of the invention which makes the combination now claimed essentially different. But the most serious objection, in the view of this patent which I take is, that it is a crude description of an invention which as described had no practical utility. None of the elements of the combination was new in itself. I am satisfied, as I have said, that the combination as described by the patentee could not be efficiently worked without at least two essential alterations—(1) That the secondary batteries must be charged when the lamps were not in the circuit with a current of electricity of a voltage which the lamps would not bear; and (2) That these batteries would be practically useless unless they were worked with switches, as I have before mentioned. Without such an arrangement they could not be made to keep the electromotive force constant in the main wires. The automatic action which Mr. Lane-Fox supposed would accomplish this is, I am persuaded, a mere delusion. These two essential alterations were necessary to make accumulators of use. Neither of them is contemplated by Lane-Fox. Assuming that he was the first to suggest the placing of reservoir batteries in communication with the main wires in a system of electric lighting by branches from the main, his mode of doing this was practically useless, and for this reason I agree with the result at which the the learned Judge has arrived. I think the patent is invalid, and that this appeal should be dismissed.

The appeal dismissed accordingly, with costs against the appellant.

Clegg & Sons v. the International Okonite Company.—Judgment was given in this action, which was tried last week in Liverpool, and was brought to recover payment for professional services rendered. The plaintiffs are architects in Manchester, and the defendants the Manufacturers at Newton Heath of electrical wires and cables. The work performed by the plaintiffs was connected with the erection of a factory for the defendants, who counterclaimed for damages for alleged negligence. His Lordship, in the course of his remarks, said the plaintiffs' claim was for £129 13s. 3d., being the balance of commission earned and for work done. He had carefully looked into the matter, and had come to the conclusion that Mr. Clegg's recollection as to the remuneration—whether 3 per cent., as the plaintiffs alleged, or 2½ per cent.—was to be preferred, and he was of opinion that the plaintiffs had made out that part of their case, subject to any small deduction in regard to the amount on which the commission was to be paid. The second item in the claim, £73 6s., was for the preparation of plans, original surveys, &c., and he thought the claim was fair and reasonable. As to the counterclaim, he did not find that the defendants had suffered any damage by reason of any negligence on the part of the plaintiffs, and he therefore gave judgment for the plaintiffs on the claim and counterclaim, with costs.

NEW PATENTS—1892.

13,932. "Improvements in telephone switch-boards." J. W. YATES and H. T. YATES. Dated August 2nd.

13,989. "Improvements in telephones." J. W. GIBBONEY and E. THOMSON. Dated August 2nd. (*Complete.*)

13,996. "Improvements in electrical generators." W. HENRY. Dated August 2nd. (*Complete.*)

14,035. "An improvement in electric incandescent lamps." J. PINTER. Dated August 3rd. (*Complete.*)

14,039. "An improved process and apparatus for the purification of sewage, and the production of alkalies, chlorine, ferric chloride, and electric energy," W. WALKER. Dated August 3rd.

14,044. "Electrodes for secondary batteries." J. C. FELL. (Communicated by W. Morrison, United States.) Dated August 3rd. (*Complete.*)

14,056. "Improvements relating to electric motors." H. H. LAKE. (Communicated by W. Stanley, jun., and J. F. Kelly, United States.) Dated August 3rd. (*Complete.*)

14,060. "Improvements in dynamo-electric and electro-dynamic machines." A. I. GRAVIER. Dated August 3rd.

14,064. "A continuous direct electric current machine and motor." W. ALDRED. Dated August 4th.

14,089. "Improvements in dry batteries." C. C. LESENBERG and J. VON DER POPPENBURG. Dated August 4th. (*Complete.*)

14,096. "Improvements in automatic electric arc lamps." G. H. CHURCH. Dated August 4th.

14,102. "Improvements in or connected with electrically applying railway brakes." W. P. THOMPSON. (Communicated by O. Berndt, Germany.) Dated August 4th. (*Complete.*)

14,124. "Electrical machinery and apparatus for excavating and removing coal or other minerals, partly applicable to other purposes." F. HURD. Dated August 4th.

14,160. "Electric apparatus for working the elevating and training gear of guns and the lifts for their ammunition." G. S. GRIMSTON. Dated August 5th.

14,180. "Improvements in or connected with electric batteries." J. L. DOBELL. Dated August 5th.

14,181. "Improvements in or connected with electric batteries." C. P. SHREWSBURY and J. L. DOBELL. Dated August 5th.

14,189. "An improved method of and apparatus for distributing alternating electric currents." H. H. LAKE. (Communicated by W. Stanley, jun., and J. F. Kelly, United States.) Dated August 5th. (*Complete.*)

14,193. "Improvements in or relating to electrically controlled valves." A. FRANKE. Dated August 5th.

14,199. "A new and improved form of electric testing instrument." A. A. DAY. Dated August 6th.

14,206. "Improvements in or connected with electric batteries." J. L. DOBELL. Dated August 6th.

CORRESPONDENCE.

Electropathic Belts.

Mr. Desmond G. FitzGerald has forwarded us the following letters, ranging over a considerable period, for publication. We refer more specially to the matter in our leading columns :—

52, Oxford Street, London, W.
(Corner of Rathbone Place.)
May 8th, 1889.

Sir,—A Post Office clerk, named J. Jerritt, of Mutley, Plymouth, has issued a pamphlet and subscription list, bearing your name (with the others mentioned overleaf), and he alleges that you formed one of the so-called "Committee" that published the pamphlet in question, entitled "An Exposure of Electrical Quackery." I shall be glad to know if this information is correct, kindly reply by return and oblige

Yours truly,
C. B. HARNESS,
President, Medical Battery Co., Limited.

Desmond G. Fitzgerald, Esq.,
6, Akerman Road, Brixton, S.W.

May 9th, 1889.

Mr. C. B. Harness,

Sir,—In answer to your letter of yesterday's date, I am unable to inform you whether I have actually been appointed a member of the committee you mention. I have, however, subscribed toward the object it has in view, and I shall moreover be happy to do anything in my power—whether as member of a committee or otherwise—towards the suppression of Electrical Quackery, and of the vendors of sham curative appliances, which are electrical only in name.

I am, Sir,
Your obedient Servant,
(Signed) DESMOND G. FITZGERALD.

52, Oxford Street, London, W.
(Corner of Rathbone Place),
August 2nd, 1892.

Dear Sir,—A gentleman, whom I believe to be a friend of yours, some time ago gave me your name as being open to carry out some electrical experiments, which I wish proceeded with at an early date. Can you undertake them? If you can call upon me, I will explain the class of experiments, and I can see you almost any time you like to appoint.

Yours faithfully,
C. B. HARNESS.

D. G. FitzGerald, Esq., M.I.C.E.
46, Loughboro' Road, Brixton.

Answered as follows :—

46, Loughboro' Road, Brixton,
4th August, 1892.

Mr. C. B. Harness.

Sir,—Referring to your letter of the 2nd inst., I beg to state that (as I have already intimated) my opinion of your "Electropathic" appliances, and of the methods by which they have been foisted upon an ignorant public, is such as to preclude me from entering into any relations with you such as you propose.

I am, Sir,
Yours truthfully,
DESMOND G. FITZGERALD.

52, Oxford Street, London, W.
(Corner of Rathbone Place),
August 9th, 1892.

Dear Sir,—In thanking you for your letter of the 4th inst., I must express my surprise that you should allow yourself to be guilty of statements as absurd as they are false.

Your departure from the main issue between us to the "ignorant public," is an illustration of the fact that there is nothing more adverse to accuracy than fixity of opinion; and that the fanciful surmises of a few prejudiced men connected with the electric lighting branch of science, wear not even the aspect of truth, their authors being entirely ignorant of the consistent realities of medical electricity. *Parturiunt montes, nascetur ridiculus mus.* Until the receipt of your letter, I had no idea that you had expressed any opinion upon the subject; my desire in writing you was to approach (as I thought) a scientist, with a view to making a public statement of the therapeutic effect of mild electric currents, and I much regret that my honest endeavours have not been reciprocated, for I had earnestly hoped that you would have been one of the first to lend your aid and the benefit of your experience to an impartial practical investigation.

Whilst maintaining the unassailability of my premises, and the correctness of my deductions on the questions of electro-therapeutics, I am, with every assurance of good-will,

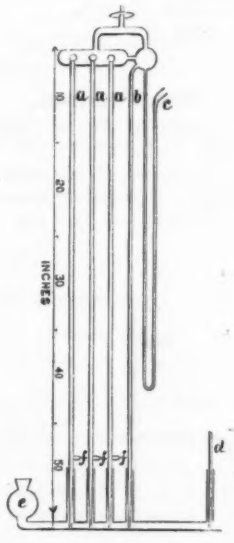
Yours faithfully,
C. B. HARNESS.

Mr. D. G. FitzGerald,
46, Loughboro' Road, Brixton.

Mercury Pumps.

I enclose a sketch of an inverted Sprengel mercury elevator, which I have had in use during the last eight or nine months, and which may perhaps be on somewhat the same lines as that of Mr. F. J. Smith, M.A., mentioned in your last issue.

I find that tubes of 2 mm. internal diameter will supply about 60 cubic cm. of mercury per minute when the upper system is exhausted to a 26-inch vacuum, but have not been able to obtain as good results as I expected.



As an ordinary five-fall Sprengel pump requires from 200 to 250 cubic cm. of mercury per minute, the number of tubes required would prohibit it from factory use; but I have found it most satisfactory for experimental work, as given the necessary 26-inch vacuum, it is self-starting, and requires no attention whatever. An accessory tube, not shown in the sketch, dries the air for the supply tubes and reservoir.

Arthur Spain, A.I.E.E.

Molenwater, Middelburg, Holland,
August 8th, 1892.

Iron for Dynamos.

We note in your issue of August 5th a paragraph headed "Iron for Dynamos." We should be glad if you will allow us space for a few remarks in this connection.

Experiments were made long ago with cast-steel to see if it could be made to supersede wrought-iron in dynamo magnet cores. Several important dynamo makers have tried this, with very doubtful results. Iron or steel castings, in common with iron forgings, have to be machined, and any difference on this point in favour of castings is very small. Wrought-iron forgings can be supplied always with a high uniform standard of permeability; but it is very difficult to get two steel castings alike in this respect. In the case of large dynamos it would be no advantage, but rather the reverse, to cast the limbs and yoke in one piece. Any examination of the armature is far more easily accomplished with wrought-iron limbs and yoke which are bolted together and readily separated, than with a huge mass such as the limbs and yoke in one piece would be. We think the main difficulty, however, would be the difference in the cost of the two materials. We should very much like to see a steel casting showing 90 per cent. of the permeability of wrought-iron at anything approaching the cost of wrought-iron forgings.

It seems to us that the only method of getting material which will increase the output of dynamos for the same weight of wrought-iron is by a process of compressing. We have a material which is practically uncastable, and at the same time is too soft to manipulate under the hammer; and, so far as tests up to the present have indicated, it is fully 10 per cent. better than ordinary wrought-iron. We have for some months been experimenting with this material under a very heavy press, and we hope soon to be able to place before the dynamo builders their magnet cores pressed into shape very close to dimensions, and, as indicated above, with about 10 per cent. less weight required for a given output than would be required in wrought-iron.

The use of steel castings would certainly reduce the weight of small size dynamos where these are now built entirely of cast-iron (with the exception, of course, of the armature). But here arises the question of intricate castings, which, if in steel, are very difficult to get sound and cheap. We have by us a set of steel castings for a small dynamo which cost 60s. per cwt., and we shall be pleased to make a present of these to any dynamo maker who wishes to experiment with steel castings.

Harold & Jenkins.

August, 1892.

The Accuracy of "Lightning."

Messrs. Hammond & Co. writing to *Lightning* endeavour to claim installations erected by them as the earliest attempts to distribute electricity, citing, Hastings, Eastbourne, and Brighton as installations erected in the "early eighties," and this firm sets itself up as the pioneer of high tension alternating current distribution. Such claims are ridiculously absurd.

The first attempts at electrical distribution in this country and elsewhere were made by the Edison people with their Jumbo dynamos (low tension continuous current), for instance, along Holborn in 1882.

The pioneers of the alternating current distribution system were Gaulard & Gibbs, Zipernowski & Deri, Westinghouse, Ferranti, Kennedy, and one or two others. In 1884, Zipernowski made the subject public at the B. A. meeting of that year; in 1886, Ferranti established the Grosvenor Gallery system; but it was not until the "*late eighties*" that Hammond & Co. and every other company in the trade rushed into the alternating current business. In 1887, Kennedy's work on the subject appeared. Considering these facts it is hard to see where Messrs Hammond & Co. come in as "pioneers." The installations referred to are faithful copies of works planned and carried to perfection by the aforesaid pioneers, and the firms now offering high tension alternating current machinery and systems can claim very little originality. Everyone offers just the same

as his competitors, namely, alternators, transformers &c., designed, constructed, and operated on the lines discovered and laid down by the real "pioneers."

The Writer of the Article.

Submarine Cable Relays.

In your issue of 8th inst., I see a note stating that Mr. E. Raymond Barker is bringing forward a development of the submarine cable relay recently patented by me; the point of difference being the substitution of a liquid resistance for the carbon springs. While undoubtedly this idea may be original with Mr. Barker, so far as he is concerned, it only once more proves the correctness of the old adage of there being nothing new under the sun. My first experiments were made on this line upwards of six years since, and signals have been read by Mr. Clapperton, superintendent of the Commercial Cable Company, New York, which were sent from Canso, U.S., and translated by this device into two sounders, made to represent the two bells of a Bright's bell system. While I have never discarded this device, I soon saw difficulties, owing to the formation of bubbles on the respective electrodes which would alter the resistances very materially in the different differential circuits, and make false signals even when the instrument was at rest. Of course, not knowing the device used by Mr. Barker, and having seen nothing but the short mention of your issue of the 8th, I would not undertake to criticise the perfection to which the present device may have attained. I simply wish by this note to let it be known that I have not confined my experiments to carbon helices; but, seeing many difficulties in the way of using a liquid resistance, I realised that for an instrument that would not require constant watching, it was better to make the variables of a non-polarisable material. I further found that the liquid device was patented by Varley some years before I made my experiments, and I think it was when I was describing my first device to Dr. Alexander Muirhead that he told me of Varley's experiments, and showed me a copy of the patent. In my experiments, a fine platinum wire was threaded through the siphon of a recorder, and its point caused to move in a fine trough of water of about $\frac{1}{32}$ to $\frac{1}{16}$ inch section and $\frac{3}{4}$ inch long, each end of the trough connecting with a larger vessel in which were placed the terminals of a battery of any required number of cells. A wire from the centre of the battery was carried through the translating relay and back to the siphon; of course the centre of the trough was the point of equi-potential, and any variation from these gave the positive or negative currents in our translating relay as determined by the received current in the primary recorder.

Of the various modifications and changes that were rung on this device there is no need for mention; but signals of Morse, Bright's bells, and recorder signals, were obtained in the second circuit, and had I not aimed at a more fixed (if I can so use the word) instrument, I should have been content with the results, and more would have been known about the device at that time.

Pardon the length to which I have written, but it is better in all cases to be explicit, as it avoids the appearance of wishing to belittle the work of a brother investigator.

Chas. Cuttriss.

Duxbury, Mass., *July 29th*, 1892.

Improvements in Crossley and Ader Microphones.

Experience with the Crossley and Ader microphones, applied to telephones, proved that the batteries (No. 2 Leclanché cells) used on them soon became exhausted, which rendered the telephones a constant source of trouble and expense. In fact, often after about four months' use the porous pots, which were of the Silvertown Telegraph Company's make, were quite useless.

Upon looking into the matter, I found that this effect was owing to the low resistance of the microphone circuit causing a heavy output from the cells. The resistance of the Crossley microphone, with eight carbons in parallel, is 2·5 ω., whilst that of the Ader microphone, with 10 carbons in parallel, is 2 ω. This shows an average of about 20 ω. per carbon, that is, one carbon, with its two loose contacts.

Looking at these low resistances, when placed in series with two Leclanché cells (No. 2) coupled in series, with an approximate E.M.F. of 1·5, and resistance of 1·5 per cell, and the primary of an induction coil with ·5 ω. resistance, we find the following outputs, viz.:—

For the battery on the Crossley microphone, 500 milliampères.
" " " Ader " 545 "

These figures show that in the former case there is an output of half an ampère, and in the latter of over half an ampère. This output is too heavy for No. 2 Leclanché cells when they are used very often, and accounts for the short life of the cells.

The instruments upon which the experience was gained were used on busy railway circuits, between suburban stations and signal boxes, on circuits of five or six instruments. On these instruments the whole of the suburban railway telegraph business was done, besides all ordinary traffic matters, and they were being used almost continuously, so to speak, both during the day and the night.

To reduce this heavy output, and so increase the life of the cells, I tried increasing the resistance of the microphone, by using one carbon only with its two supports, and placing it in the centre of the diaphragm. When this arrangement was tried on similar cells and induction coils, as above, it gave excellent results, and when placed on several long lines of high resistance, the speech was as clear and distinct as that of one of the best Hunnings transmitters.

In fact, it has the advantage over the Hunnings transmitter, that it requires absolutely no adjustment or re-adjustment as the cells run down.

The output of the cells in this case would be about 127 milliampères, or a little less than one-eighth of an ampère, and this, it will be seen, considerably increases the life of the cells, as only about one-fourth of the current is used.

I have now had many of the Crossley and Ader microphones altered to the single carbon form, and in all cases with great success. In some cases, when the pencil was left too loose in its bearings, it was found too sensitive; but this was always overcome by slightly twisting the bearings, so as to hold the carbon a little firmer.

The diaphragms used were of pitch pine, $\frac{1}{16}$th-inch thick, and 5 inches by 4 inches, and they were screwed down as firm as possible on their edges.

The microphone is simply Hughes's first form, and nothing original is claimed for it.

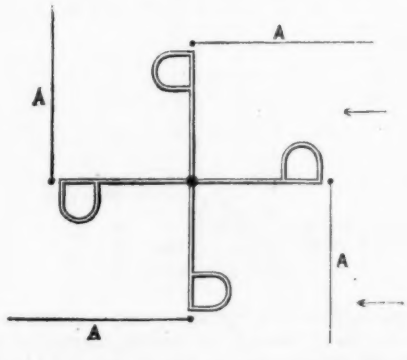
W. D. Filmer.

New South Wales Government
Railways and Tramways, Sydney,
July 4th, 1892.

Blyth's Windmill.

I notice in your paper of August 12th, a description of Pro. Blyth's new form of windmill.

Five years ago, I put up one of the same construction but on a much smaller scale. I used four semi-cylindrical boxes of sheet-iron, each about 10 feet by 2 feet, attached to four



arms. I found, however, that the power was greatly increased by placing four or more screens at right angles to the diameter of the circle described by the horizontal arms as in enclosed sketch, where A A A A are the screens. I should much like to know if this has been tried on a large scale, and, if so, the results.

W. J. S. Barber-Starkey.

August 15th, 1892.